MP MASTER
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5500A

AUTOMETRONIC

COUNTER-TIMER

BALLANTINE LABORATORIES, INC.

P.O. BOX 97
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WARRANTY

All Ballantine Laboratories, Inc. products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, except for vacuum tubes and batteries, or, in the case of certain major components listed in the instruction manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

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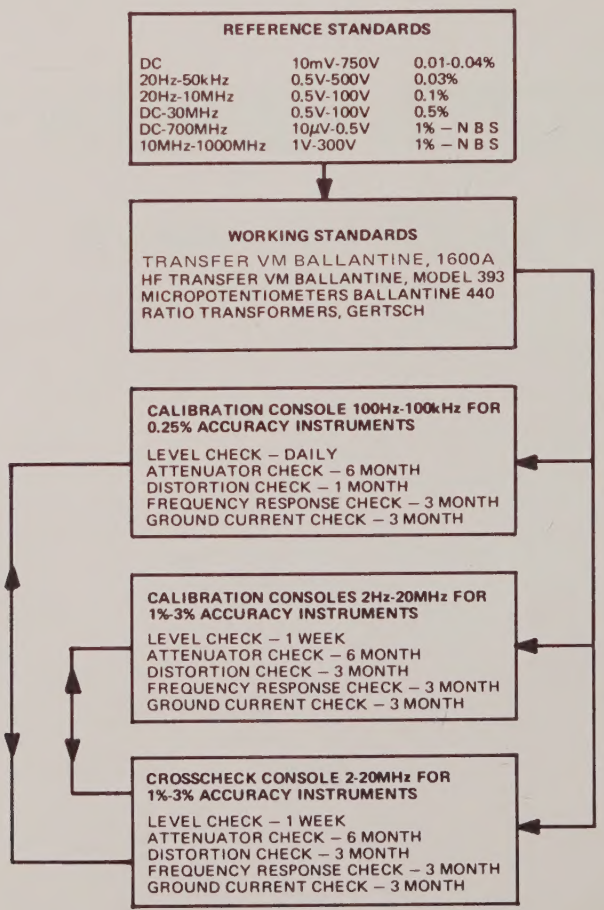
The equipment supplied on your order meets all applicable published Ballantine specifications as determined by thorough testing and inspection. Ballantine's calibration measurements are traceable to the National Bureau of Standards. All instruments used in calibrating Ballantine products are standardized by systematic reference to NBS-traceable standards as described in the validation procedures shown below.


REFERENCE STANDARDS
DC 10mV-750V 0.01-0.04%
20Hz-50kHz 0.5V-500V 0.03%
20Hz-10MHz 0.5V-100V 0.1%
DC-30MHz 0.5V-100V 0.5%
DC-700MHz 10μV-0.5V 1% – N B S
10MHz-1000MHz 1V-300V 1% – N B S
WORKING STANDARDS
TRANSFER VM BALLANTINE, 1600A
HF TRANSFER VM BALLANTINE, MODEL 393
MICROPOTENTIOMETERS BALLANTINE 440
RATIO TRANSFORMERS, GERTSCH
CALIBRATION CONSOLE 100Hz-100kHz FOR 0.25% ACCURACY INSTRUMENTS
LEVEL CHECK – DAILY
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 1 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CALIBRATION CONSOLES 2Hz-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CROSSCHECK CONSOLE 2-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

Ballantine's Quality Assurance program satisfies the requirements of MIL-I-45208

TABLE OF CONTENTS

	Page
SECTION 1. GENERAL INFORMATION	1-1
SECTION 2. INSTALLATION	2-1
2-1. Introduction	2-1
2-2. Unpacking and Inspection	2-1
2-3. Power Connection Caution	2-1
2-4. Cooling	2-1
2-5. Remote Programming	2-1
2-6. Digital Recorder	2-1
2-7. Clock Selection	2-1
SECTION 3. OPERATION	3-1
3-1. Introduction	3-1
3-2. Controls Connectors Indicators	3-1
3-3. General Operating Information	3-2
3-4. Input Circuit Adjustment	3-5
3-5. Performance Test	3-5
3-6. Operating Procedures	3-5
SECTION 4. PRINCIPLES OF OPERATION	4-1
4-1. Introduction	4-1
4-2. Assembly Designations	4-1
4-3. Channel A Input Circuit Operation	4-6
4-4. Channel B Input Circuit Operation	4-6
4-5. 10 MHz Oscillator Operation	4-6
4-6. Ext Clock in/1 MHz Clock Out Operation	4-6
4-7. Control Logic Operation	4-6
4-8. Sample Rate and Reset Circuit	4-7
4-9. Gate Indicator, Transfer Print Command Circuits	4-8
4-10. Display Circuit	4-8
4-11. Power Supply	4-8
SECTION 5. MAINTENANCE AND CALIBRATION	5-1
5-1. Introduction	5-1
5-2. Test Equipment	5-1
5-3. Instrument Cover Removal	5-1
5-4. Cleaning	5-1
5-5. Visual Inspection	5-1
5-6. Repair and Replacement	5-1
5-7. Channel A Input Circuit Adjustment	5-1
5-8. Channel B Input Circuit Adjustment	5-3
5-9. Troubleshooting By Self-Check	5-3
5-10. In-Cabinet Performance Check	5-3
5-11. Oscillator Calibration	5-4
5-12. Packing	5-6
SECTION 6. PARTS LIST	6-1
Front Panel A1	6-2
Rear Panel A2	6-2
Motherboard A3	6-2
Display Assembly A4	6-4
Input Assembly A5	6-5
Miscellaneous	6-6
SECTION 7. CIRCUIT DIAGRAMS	7-1

LIST OF ILLUSTRATIONS

Figure		*Page*
1-1.	5500A Autometronic Counter-Timer	1-1
1-2.	Conventional Frequency Counter Block Diagram	1-2
1-3.	Conventional Period and Time Interval Meter Block Diagram	1-3
3-1.	Controls, Connectors and Indicators	3-0
4-1.	5500A Simplified Block Diagram	4-1
4-2.	Count Mode Flow Diagram	4-2
4-3.	Frequency Mode Flow Diagram	4-2
4-4.	Period Mode Flow Diagram	4-3
4-5.	Positive or Negative Pulsewidth	4-3
4-6.	Period Average Mode Flow Diagram	4-4
4-7.	Time A→ B Mode Flow Diagram	4-4
4-8.	A/NB (Ratio) Mode Flow Diagram	4-5
4-9.	Time Interval Mode Flow Diagram	4-5
7-1.	Component Locations, Front Panel A1 & Rear Panel A2	7-1
7-2.	Component Locations, Motherboard A3	7-2
7-3.	Test Point Waveforms, Motherboard A3	7-3
7-4.	Schematic, Motherboard A3	7-3
7-5.	Component Locations, Display Assembly A4	7-4
7-6.	Test Point Waveforms, Display Assembly A4	7-5
7-7.	Schematic, Display Assembly A4	7-5
7-8.	Component Locations, Input Circuit A5	7-6
7-9.	Test Point Waveforms, Input Circuit A5	7-7
7-10.	Schematic, Front Panel A1 & Input Circuit A5	7-7

LIST OF TABLES

Table		*Page*
1-1.	Specifications	1-4
2-1.	REMOTE PROG Connector	2-0
2-2.	PRINTER Connector	2-0
3-1.	Controls, Connectors and Indicators	3-1
3-2.	Frequency Measurement Data	3-4
3-3.	Period Measurement Data	3-4
3-4.	Period Average Measurement Data	3-4
4-1.	Assembly Identification	4-1
5-1.	Recommended Test Equipment	5-2
5-2.	Frequency Mode Performance Check	5-2
5-3.	Period Mode Performance Check	5-4
5-4.	Period Average Performance Check	5-5
5-5.	Time A → B Performance Check	5-5
5-6.	Time A → B, Slope Selection Check	5-5
5-7.	A/NB Ratio Mode	5-5

Notes

General Information

The Ballantine Autometronic Counter-Timer 5500A is a compact and lightweight instrument for precise frequency and time measurements. It contains a unique autoranging circuit (patent pending) that enables time and frequency measurements to be made without the need for any operator adjustments.

To familiarize the operator with the automatic operation of the 5500A, the following short description will describe the operation of a conventional, manually operated Counter-Timer, explain the difficulties involved in measuring frequency and time, and indicate how the problems are solved in the 5500A.

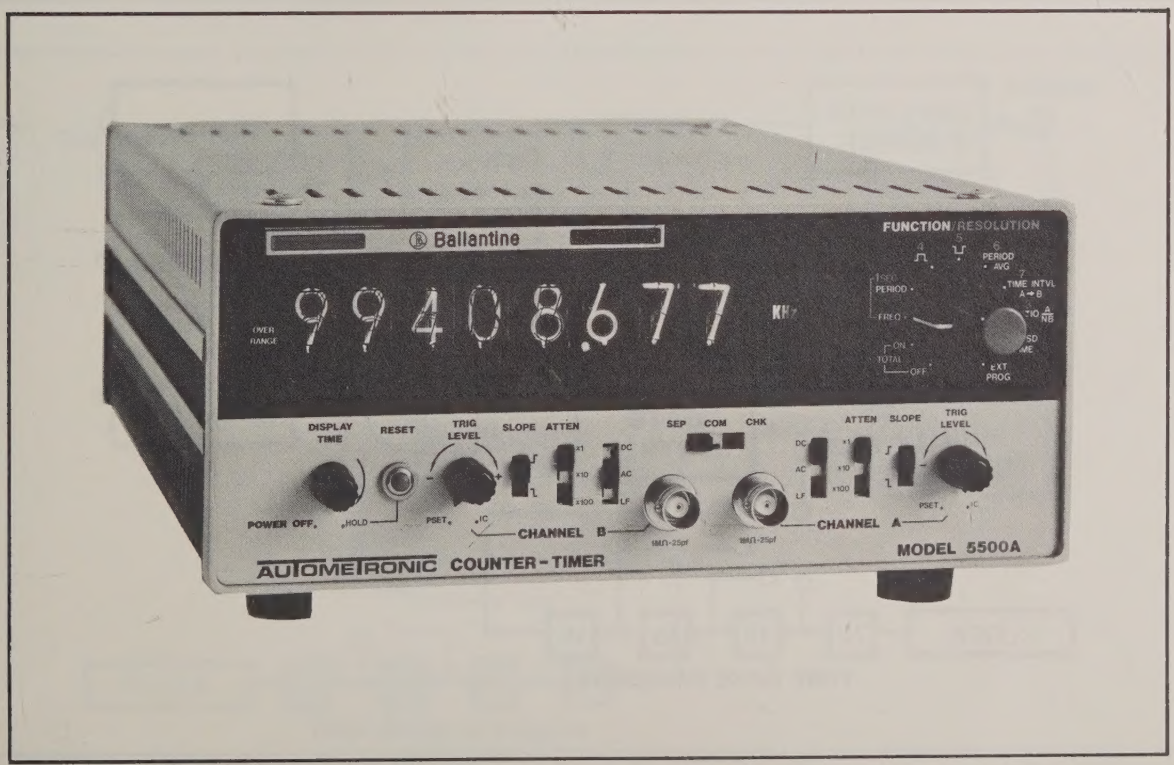


Figure 1-1. 5500A Autometronic Counter-Timer

FREQUENCY MEASUREMENTS:

In a conventional, manually operated electronic Counter-Timer, frequency measurements are performed as follows (see figure 1-2).

The input signal is amplified and shaped (1) in order to present pulses of uniform amplitude and rise time to the decade counters (5), regardless of the frequency or waveform of the input signal. The signal gate (4) controls the flow of the shaped pulses to the decade counters. When the signal gate is enabled (opened) by a pulse from the time base dividers (3) the shaped pulses pass through and are counted by the decade counters. The next pulse from the time base chain disables (closes) the gate. The count accumulated in the decade counters is decoded (6) to convert the information into useful signals to operate the display (7). The open gate interval is usually available in decade steps, derived from the basic clock period.

With conventional frequency counters, the operator must adjust the gate time selector (time base) and make measurements at several time base frequencies until maximum resolution is seen on the readout. This method of time base selection increases the measurement time, and complicates the design of systems incorporating frequency counters. Where signals of wide frequency range are to be measured, measurements are made very difficult, if not impossible.

The Autoranging feature enables the 5500A to overcome all the disadvantages of manual time base selection. The Autoranging circuitry automatically adjusts the time base of the instrument such that:

a. The display capacity is never exceeded.
b. The best possible resolution is always obtained, automatically.
c. Units of measurement (KHz, MHz) are automatically displayed.
d. The decimal point is computed and automatically placed in its correct position.

The automatic time base selection operation is concurrent with the measurement process. Thus maximum resolution is automatically obtained and needs no attention by the operator, or additional programming operations in an automatic measuring system. This increases measurement speed and simplifies system design. Signals of wide frequency range are immediately computed and displayed with maximum resolution.

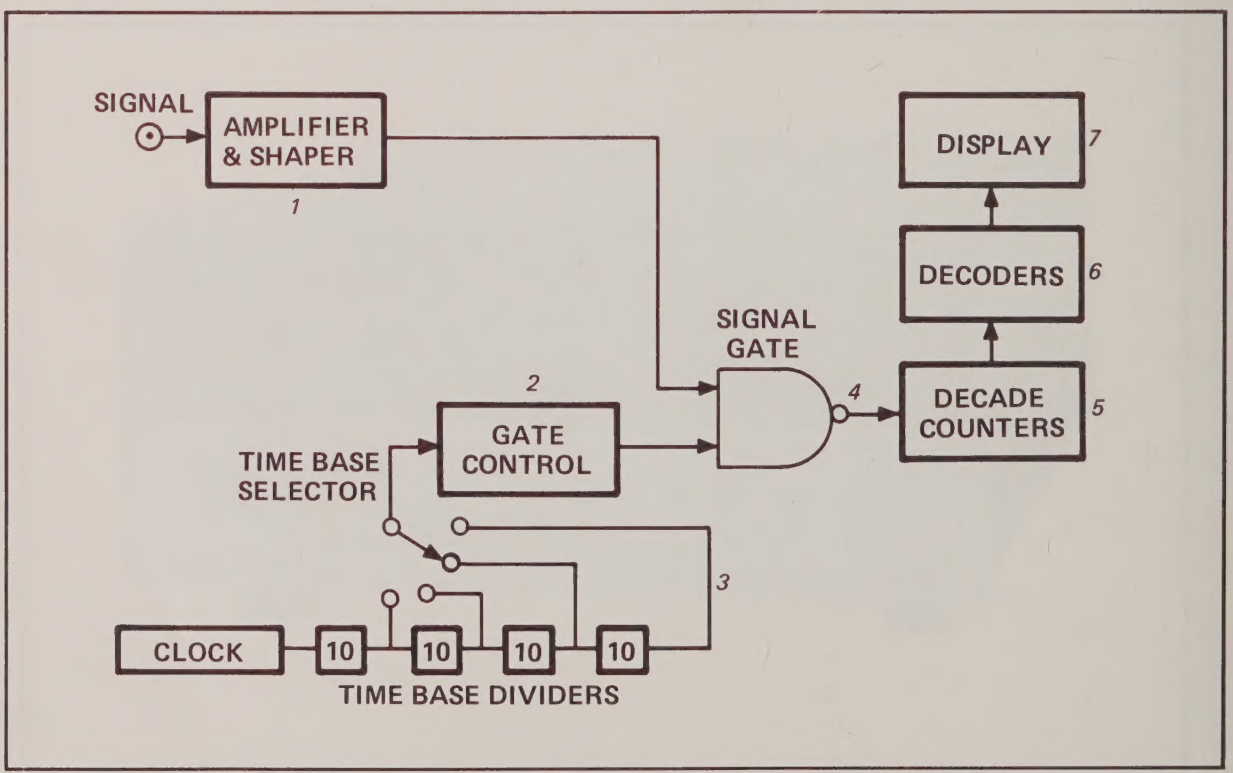


Figure 1-2. Conventional Frequency Counter Block Diagram

PERIOD AND TIME INTERVAL MEASUREMENTS:

In a conventional, manually operated electronic Counter-Timer, period or time interval measurements are performed as follows (see figure 1-3).

The input signal is applied to the amplifier and shaper (1) which converts the input signal to pulses of uniform amplitude and rise time. The shaped input signal operates a gate control circuit (2) which produces a gating pulse for the signal gate (4), equal in time to the period of the input signal. While the signal gate is enabled (open), pulses from the time base (3) pass through the signal gate to the decade counters (5). After the signal gate is closed, the count accumulated in the decade counters is decoded (6) to convert the information into useful signals to operate the display (7).

The difficulty in measuring period and time interval with the conventional method is that the operator has to know in advance the approximate duration of the signal in order to select a suitable time base (range) which will give the required resolution and prevent display overflow. If the input signal is repetitive, the operator will try to select manually, by making a few measurements, a suitable time unit for best results. However, if the input signal is non-repetitive or the time interval to be measured is of random duration, measurements are made very difficult, if not impossible.

The Autoranging feature enables the 5500A to overcome all the disadvantages of manual time base selection. The Autoranging circuitry automatically adjusts the time base units such that:

a. The display capacity is never exceeded, except for impracticably long periods (K X 10^n seconds, where K is the lowest time unit and n the number of digits of the counter).
b. The best possible resolution is always obtained, automatically.
c. Units of measurement (microseconds, milliseconds or seconds) are automatically displayed.
d. The decimal point is computed and automatically placed in its correct position.

The automatic time base selection operation is concurrent with the measurement process, so that signals of random duration or duration changes are immediately computed and displayed with maximum resolution.

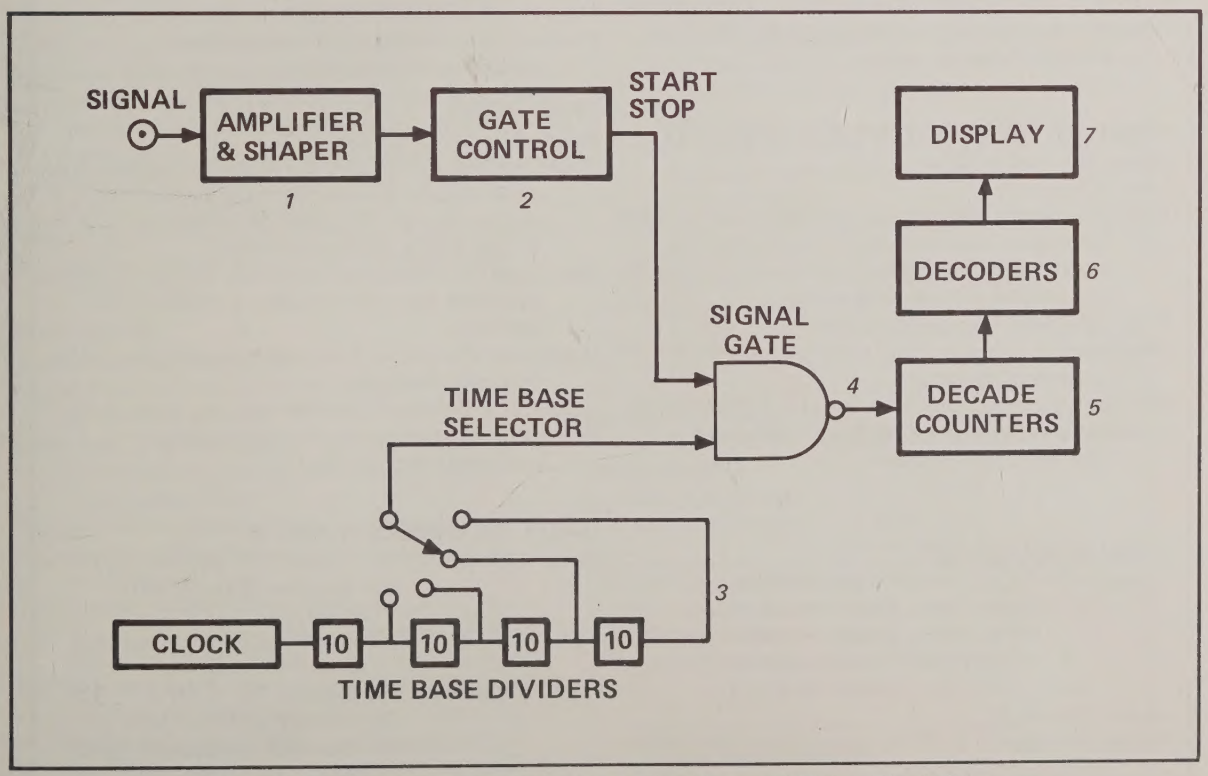


Figure 1-3. Conventional Period and Time Interval Meter Block Diagram

Table 1-1. Specifications

COUNT

Frequency: DC to 90 MHz
(DC to 110 MHz with option MOD 10)
Counter Range: 1 to 10^8 counts.
Input: Channel A.
Gate Time: Manually selected.
Accuracy: Absolute.
Readout: Dimensionless.

FREQUENCY

Range: DC to 90 MHz
(MOD 10 DC to 110 MHz)
Input: Channel A.
Gate Time: Automatically selected to fill the display (up to 1 sec), or 1 sec manual. The number of digits displayed can be selected as 4, 5, 6, 7 or 8 by a front-panel switch.
Accuracy: ± 1 count ± time-base accuracy.
Readout: kHz or MHz, with automatically positioned decimal point.

PERIOD

Range: 100 nsec to 10^8 seconds.
Input: Channel A.
Clock Frequency: 100 nsec to 1 second in decimal steps, automatically selected to fill the display. The number of digits displayed can be selected as 4, 5, 6, 7, or 8 by a front-panel switch.
Resolution: 0.1 μsec to 1 sec, automatically selected for maximum resolution.
Accuracy: ± count ± time-base accuracy ± trigger error*.
Readout: μsec, msec or sec, with automatically positioned decimal point.

POSITIVE OR NEGATIVE PULSE WIDTH

Range: 0.1 μsec to 10^8 sec.
Input: Channel A.
Clock Frequency: 100 nsec to 1 second in decimal steps, automatically selected to fill the display. The number of digits displayed can be selected as 4, 5, 6, 7, or 8 by a front-panel switch.
Slope Selection: Automatically selected.
Resolution: 0.1 μsec to 1 sec, automatically selected for maximum resolution.
Accuracy: ± count ± time-base accuracy ± trigger error*.
Readout: μsec, msec or sec, with automatically positioned decimal point.

PERIOD AVERAGE

Range: 100 Hz to 1 MHz, 4-digit resolution.
10 Hz to 1 MHz, 5-digit resolution.
1 Hz to 1 MHz, 6-digit resolution.
0.1 Hz to 1 MHz, 7-digit resolution.
0.01 Hz to 1 MHz, 8-digit resolution.
Input: Channel A.
Periods Averaged: 1 to 1000, automatically selected for maximum resolution.
Clock Frequency: 1 MHz.
Accuracy: ± count ± time-base accuracy ± trigger error*
Readout: μsec, with automatically positioned decimal point.

TIME A→B

Range: 0.1 μsec to 10^8 sec.
Input: Start Signal: Channel A. Stop Signal: Channel B. Can be common or separate.
Clock Frequency: 100 nsec to 1 second in decimal steps, automatically selected to fill the display. The number of digits displayed can be selected as 4, 5, 6, 7, or 8 by a front-panel switch.
Resolution: 0.1 μsec to 1 sec, automatically selected for maximum resolution.
Accuracy: ± count ± time-base accuracy ± trigger error of A* ± Trigger error of B*.
Readout: μsec, msec, or sec, with automatically positioned decimal point.

RATIO A/NB

Range: Channel A: DC to 90 MHz
(MOD 10 DC to 110 MHz)
Channel B: DC to 10 MHz
Input (F1): Channel A.
Input (F2): Channel B.
Measures: F1/F2.
Number of Cycles of F2 Averaged: 1 to 1000 automatically selected for maximum resolution.
Accuracy: ± count of F1 ± trigger error of F2*.
Readout: Dimensionless, with automatically positioned decimal point.

TIME INTVL

Range: 0.1 μsec to 10^8 sec.
Clock Frequency: 100 nsec to 1 second in decimal steps, automatically selected to fill the display. The number of digits displayed can be selected as 4, 5, 6, 7, or 8 by a front-panel switch.
Gate Signal: Via rear panel connector. Contact closure to ground or saturated transistor will control the gate time.
Resolution: 0.1 μsec to 1 sec, automatically selected for maximum resolution.
Accuracy: ± 1 count ± time-base accuracy ± gate error.**
Readout: μsec, msec or sec, with automatically positioned decimal point.

INPUT CHANNELS A AND B

Range: Channel A, DC coupled: DC-90 MHz (110 MHz)
AC coupled: 20 Hz-90 MHz (110 MHz)
HF Rejection: Attenuates signals above 1 kHz approx.
Channel B, DC coupled: DC-10 MHz
AC coupled: 20 Hz-10 MHz
HF Rejection: Attenuates signals above 1 kHz approx.
Impedance: 1 megohm shunted by 25 pF approx.

Table 1-1. Specifications (Continued)

Sensitivity: 25 mV rms sine wave 0-2 MHz.
50 mV rms sine wave 2-10 MHz.
100 mV rms sine wave 10-90 MHz (channel A only) (To 110 MHz with MOD 10)
Channel A, 0.3 V peak-to-peak pulse, 7 nsec min plus width.
Channel B, 0.3 V peak-to-peak pulse, 50 nsec min plus width.
Preset: Sets trigger reference to 0 volts.
Attenuation: X1, X10, X100.
Trigger Level: Continuously adjustable ± 1 V, ± 10 V, ± 100 V, dependent upon setting of attenuator.
Slope: Independent selection of positive or negative slope.
Overload Protection: 250 V rms on X10 and X100 attenuator settings, 120 V rms on X1 attenuator setting up to 1 kHz, decreasing to 10 V rms above 10 MHz.
Shaped Outputs A and B: Terminals on the rear panel for external monitoring of the triggering points on the input signals. > 1 volt open circuit.

DISPLAY

Numerical: 6 digits (8 optional).
Units: kHz, MHz, μsec, msec or sec, automatically computed and displayed.
Decimal Point: Automatically selected.
Display Storage: Prior reading is held while new reading is being made. Display time is adjustable from 0.2 to 5 seconds or held indefinitely.
Gate: Lights up when counter gate is open.
Overrange: Solid-state indicator that lights up when the counter capacity is exceeded. Due to the automatic gate selection, the counter capacity can be exceeded only when using the manually selected 1 sec gate time in Frequency mode or in the Period Average and Ratio modes.
Manual Reset: Front-panel pushbutton switch resets the display and all registers, and initiates a new measurement.

TIME BASE

Crystal Frequency: 10 MHz
Crystal Oven: Self-regulating solid-state proportional oven.
Aging Rate: Less than 3 parts in 10^7 per month after 10 days of continuous operation. (less than 0.02 ppm per day)
Temperature Stability: Less than 2 parts in 10^6 from 0°C to +50°C. (Normally less than 0.04 ppm per °C)
Line Voltage Stability: Less than 5 parts in 10^7 for ± 10% line voltage change. (Nominally less than 0.05 ppm per % change)
Ext. Time Base Input: Via rear panel BNC connector, 1 kHz to 10 MHz, 0.5 V rms into 1 Kohm.
Int. Time Base Output: 1 MHz via rear panel BNC connector.

GENERAL

Display: 6 gas discharge type numeric indicators (7 optional)
Operating Temperature: 0°C (+32°F) to +50°C (+122°F).
Power Requirements: 115 or 230 volts ± 10%, 48 to 400 Hz, 25 watts.
Dimensions: 3-1/2" (88 mm) H x 8-3/8" (212 mm) W x 12-1/2" (316 mm) D.
Weight: 7 pounds (3.2 Kg).
Accessories Furnished: Power Cord, Service Manual.

ACCESSORIES AVAILALBE

Probe Kit — Attenuator 10:1, 5 ft., Model 10601B
50 ohm 4 ft BNC-to-BNC coaxial cable, Model 12249D
Display Extender Board, P/N 89400001A
6 ft cable to connect the 5500A to a digital recorder; 12253A
6 ft cable to connect the 5500A for remote programming; 12254A
Feed thru Termination, 50 ohm BNC, 12630A
50 ohm 4 ft BNC to alligator cable, 12250D

OPTIONS AVAILABLE

8-DIGIT DISPLAY (Option MOD 08)
PRINTER OUTPUT (Option MOD 01)
Logic: Positive True BCD & Dec. Pts., Units Negative True
Form: 4-line 1-2-4-8 BCD. "1" state level: +5 ±0.5 V 2.5 Kohm source impedance nominal. "0" state level: +0.25 V at −1 mA.
Print Command: Positive pulse of 5 V, DC coupled. Source impedance is 5 Kohm when in the "high" state and 500 ohm when in the "low" state. Pulse duration is 1 msec approx. Occurs at end of gate time.
Inhibit Input: A positive pulse of 3 V minimum and 50 V maximum will inhibit the recycling circuitry of the counter.
Connector: Amphenol 57−40500 (50-pin blue −blue ribbon). Mating connector Amphenol 57−30500. P/N 31100500A
REMOTE PROGRAMMING (Option MOD 02)
Permits function and resolution to be remotely selected by a single contact to ground or equivalent active circuit. (TTL & DTL)compatible) The time base is automatically selected for maximum resolution. Mating connector (24-pin Blue Ribbon) Amphenol 57-30240, P/N 31100370A
110 MHz CAPABILITY (Option MOD 10)
100 V/200 V POWER LINE VOLTAGE (Option MOD 50)

*Trigger error is less than 0.3% of one period divided by the number of periods averaged, for signals with a signal-to-noise ratio of 40 db or better, and 100 mV rms amplitude.
**For any waveshape, trigger error is less than

$$\frac{0.0025}{\pm \text{Signal slope (Volts/}\mu\text{s)}}$$ Microseconds.

Table 2-1. REMOTE PROG Connector

NOTE: When Remote Programming Option 02 is not part of the instrument, the 24-pin connector is replaced by banana jacks. The red banana jack is the TIME INTERVAL input; the black banana jack is ground. (See Figure 4-9).

PIN	USE	PIN	USE
1	Common	13	5 Digit Resolution
2	Count Start	14	6 Digit Resolution
3	Freq	15	7 Digit Resolution
4	Period	16	8 Digit Resolution
5	Positive Pulsewidth	17	
6	Negative Pulsewidth	18	
7	Period Avg	19	
8	Time A→B	20	
9	A/NB	21	
10	Time Intvl	22	Reset
11	1 Sec Timebase	23	Time Intvl Enable
12	4 Digit Resolution	24	GND

Table 2-2. PRINTER Connector

PIN	USE	PIN	USE
1	10^0 Decade BCD 1 Output	26	10^0 Decade BCD 4 Output
2	10^0 Decade BCD 2 Output	27	10^0 Decade BCD 8 Output
3	10^1 Decade BCD 1 Output	28	10^1 Decade BCD 4 Output
4	10^1 Decade BCD 2 Output	29	10^1 Decade BCD 8 Output
5	10^2 Decade BCD 1 Output	30	10^2 Decade BCD 4 Output
6	10^2 Decade BCD 2 Output	31	10^2 Decade BCD 8 Output
7	10^3 Decade BCD 1 Output	32	10^3 Decade BCD 4 Output
8	10^3 Decade BCD 2 Output	33	10^3 Decade BCD 8 Output
9	10^4 Decade BCD 1 Output	34	10^4 Decade BCD 4 Output
10	10^4 Decade BCD 2 Output	35	10^4 Decade BCD 8 Output
11	10^5 Decade BCD 1 Output	36	10^5 Decade BCD 4 Output
12	10^5 Decade BCD 2 Output	37	10^5 Decade BCD 8 Output
13	10^6 Decade BCD 1 Output	38	10^6 Decade BCD 4 Output
14	10^6 Decade BCD 2 Output	39	10^6 Decade BCD 8 Output
15	10^7 Decade BCD 1 Output	40	10^7 Decade BCD 4 Output
16	10^7 Decade BCD 2 Output	41	10^7 Decade BCD 8 Output
17	μsec*	42	Sec*
18	msec*	43	
19	Decimal Point 1 (right-most)	44	Decimal Point 2
20		45	Decimal Point 3
21	KHz*	46	MHz*
22	Inhibit Input	47	
23	Positive Print Command	48	
24		49	
25		50	Ground

*Units provide negative logic.

Section 2

Installation

2-1. INTRODUCTION

The 5500A is shipped in an operating condition and is essentially ready for use as received. This section contains unpacking, inspection, and installation information.

2-2. UNPACKING AND INSPECTION

Examine the shipping carton for damage before unpacking the instrument. Carefully remove the instrument from the carton. Check immediately for loose or broken control knobs, bent or broken connectors, and damage to any cabinet part. If damage of any nature is found, refer to the warranty instructions.

2-3. POWER CONNECTION CAUTION

This instrument is designed to operate from either a 115 vac or 230 vac ± 10% 50 to 400 Hz power source. The primary voltage selection is made by positioning a recessed slide switch on the rear panel. To change the position of the slide switch, insert a small screwdriver in the switch slot and set the switch to the required voltage position. Damage caused by using incorrect primary input voltage voids the instrument warranty.

WARNING

The instrument is provided with a three-conductor power cord which will ground the case when connected to a three-connector grounding outlet. If a grounding outlet is not available, an adapter must be used which provides a good grounding connection.

Option MOD 50 is available for 100/200 vac power source.

2-4. COOLING

Cooling air enters the case through holes on the covers. Adequate clearance must be provided on all sides of the instrument to allow heat to be dissipated. Be sure that the instrument position permits adequate air circulation and that nearby equipment does not discharge hot air directly on the instrument.

2-5. REMOTE PROGRAMMING

The REMOTE PROGRAMMING connector on the rear panel is an optional feature which permits remote programming of the instrument. Table 2-1 lists each of the pins in this connector and the corresponding function. Note that instrument functions can only be remotely programmed when the front panel FUNCTION/RESOLUTION switch is set to REMOTE PROGRAMMING. When the Remote Programming option is not required, two binding posts are installed, which provide a remote enable input to the instrument in the TIME INTVL mode. A logic "O" applied to the binding posts enables the internal gate and a logic "1" disables it.

The front panel controls that are programmable are the FUNCTION and RESOLUTION switches. The controls which are not programmable are: DISPLAY TIME, SEP-COM-CHK and CHANNEL A and CHANNEL B controls. Selection of remote programming is made by setting the FUNCTION switch to REMOTE PROGRAMMING. This provides a ground potential to pin 1 of the REMOTE PROGRAMMING connector. This ground can be used as an enabling level for the remote programming unit.

All lines may be controlled by TTL or DTL signals or contact closure to ground.

NOTE

When the unit is NOT being programmed, all the lines should be left open or pulled to +5 V by not less than 2 kohm.

2-6. DIGITAL RECORDER

The PRINTER connector on the rear panel is an optional feature which provides BCD outputs and control signals for operating a digital recorder. Table 2-2 lists each of the pins in the connector. The characteristics of each input and output are given in the data sheet in front of this manual.

2-7. CLOCK SELECTION

An internal 10 MHz clock is provided. There is also provision for using an external clock for increased stability or to obtain a special time base. The clock selection is made by positioning of the rear panel two-position recessed slide switch INT-EXT CLOCK to INT when using the internally provided clock, and to EXT when applying an external clock.

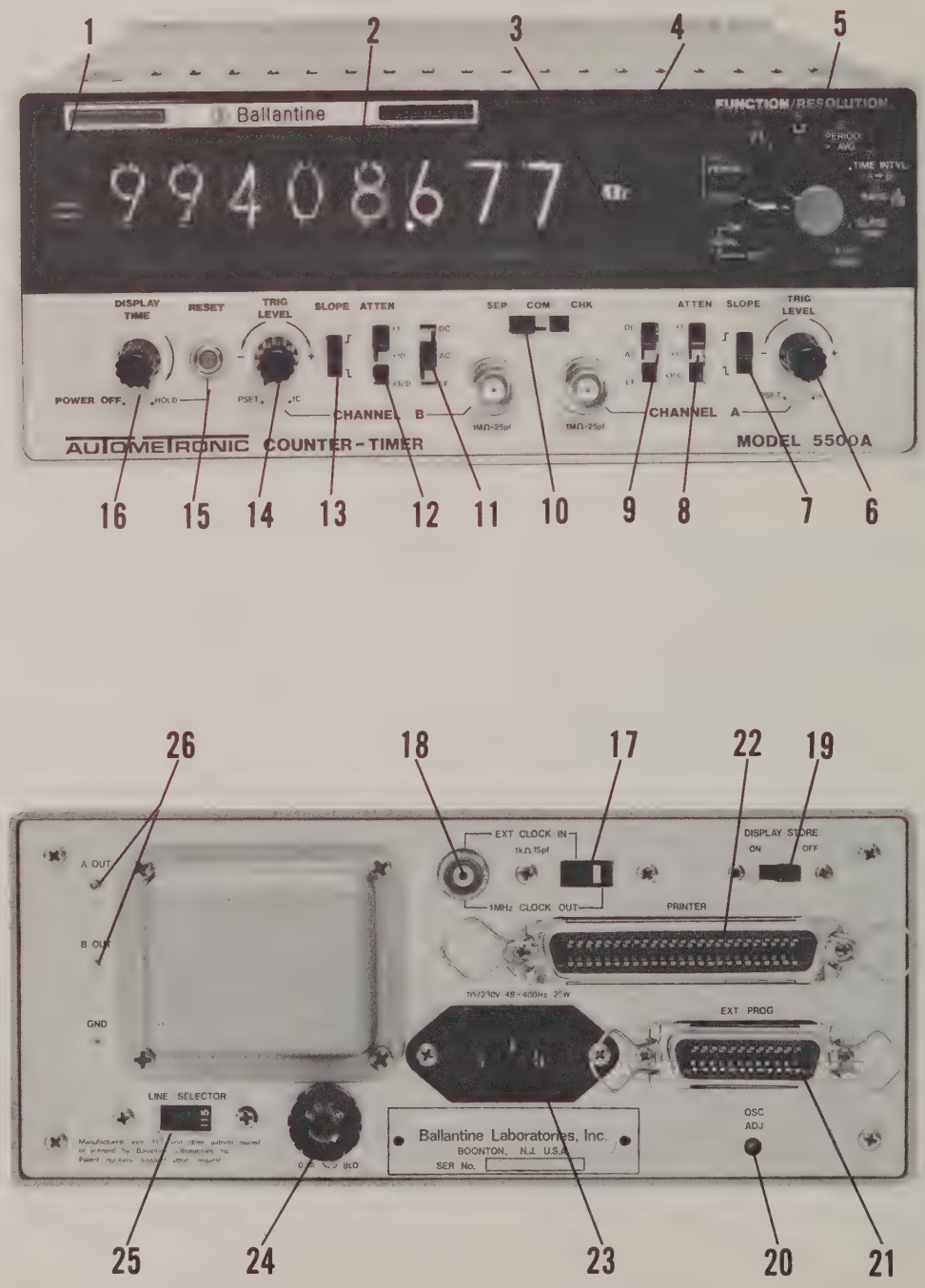


Figure 3-1. Controls, Connectors and Indicators

Section 3

Operation

3-1. INTRODUCTION

This section will familiarize the operator with the typical operation procedures of the 5500A. The front and rear panel controls, connectors, and indicators are described. Recommended operating procedures demonstrate instrument flexibility.

3-2. CONTROLS, CONNECTORS, INDICATORS

Figure 3-1 shows the instrument's front and rear panel and table 3-1 describes the function of the element located there. These descriptions are not intended to be operating instructions but, briefly, to familiarize the operator with the instrument.

Table 3-1. Controls, Connectors and Indicators

INDEX NO	ITEM	FUNCTION
1	OVER RANGE Indicator	A light emitting diode that lights up when the display range of the instrument has been exceeded.
2	Display	A six-digit (seven digit optional) numeric readout with automatically positioned decimal point that indicates the magnitude of the quantity measured. The units for the readout are shown by indicators to the right of the display (μsec, msec, sec, KHz, and MHz).
3	GATE Indicator	Indicator lamp that lights up when the instrument is counting.
4	μsec, msec, sec, KHz, MHz Indicators	Indicator lamps to show the units of the readout.
5	FUNCTION/RESOLUTION Switch	A dual concentric switch assembly. Used to select the mode of operation and the number of digits to be displayed (resolution)
6	Channel A TRIGGER LEVEL	A potentiometer that varies the triggering level of the input waveform. A preset trigger level for easy trigger setup and suitable for symmetrical-to-ground waveforms is obtained when the control is set to PSET (fully counter-clockwise). The IC position in full cw votation is provided for triggering on positive going TTL, DTL and RTL logic integrated circuits.
7	Channel A SLOPE Switch	A two-position slide switch that permits triggering on either positive or negative edges of a signal supplied to Channel A in the PERIOD, PERIOD AVG and TIME A-B modes. In all other modes, the slope selection is internal.
8	Channel A ATTEN Switch	A three-position slide switch that varies the attenuation (X1, X10, X100) of the signal applied to the Channel A connector.
9	Channel A Coupling Selector	A three-position slide switch that selects the coupling (AC or DC) or attenuates signals above 1 KHz (LF).
10	SEP-COM-CHK Switch	A three-position slide switch that connects Channel A and Channel B input circuits to a common input connector (Input A) or to separate connectors. In the position CHK (check) the internal 1 MHz oscillator is applied simultaneously to both channels.

Continued on next page

Table 3-1. Controls, Connectors and Indicators (Continued)

11	Channel B Coupling Selector	Similiar to Channel A Coupling Selector
12	Channel B ATTEN Switch	Similiar to Channel A ATTEN Switch
13	Channel B SLOPE Switch	Similiar to Channel A SLOPE
14	Channel B TRIGGER LEVEL Control	Similiar to Channel A TRIGGER LEVEL Control
15	RESET Pushbutton	Resets display and internal count to zero and starts a new measurement.
16	DISPLAY TIME Control	A switch/potentiometer control that applies ac power to the instrument, and controls the display time.
17	INT-EXT CLOCK Switch	A recessed two-position slide switch that permits selection of either the internal clock or an external clock. When set to INT, a 1 MHz signal derived from the internal clock is available to the 1 MHz CLOCK OUT BNC Connector.
18	Clock In-Out Connector	A BNC connector that enables either the application of an external clock to the instrument or provision of the internal clock from the instrument.
19	STORAGE Switch	A two-position slide switch. When set to ON, provides display storage while new measurement is being made. In OFF position, allows continous display.
20	OSC ADJ	A trimmer capacitor used for oscillator adjustment.
21	REMOTE PROG Connector	A 24-pin connector for remote programming signals to the instrument.
22	PRINTER Connector	A 50-pin connector for digital recorder interconnection.
23	AC Power Connector	IEC type with offset pin connected to instrument chassis.
24	Fuse	Protects primary power circuit from accidental overload.
25	LINE SELECTOR Switch	Selects the nominal line voltage to operate the instrument.
26	A OUT, B OUT Terminals	Used for monitoring of the triggering points on the input signals.

3-3. GENERAL OPERATING INFORMATION

The 5500A has ten operating modes and a test mode. The operating modes are: COUNT, FREQ, PERIOD, POSITIVE PULSEWIDTH, NEGATIVE PULSEWIDTH, PERIOD AVERAGE, TIME A→B, RATIO A/NB, TIME INTVL and REMOTE PROG. The REMOTE PROGRAMMING Mode permits remote operation of any of the instrument functions except the test mode. The following is a description of each operating mode and a typical application for each. The test mode is described in paragraph 3-5.

COUNT MODE:

In the count mode, the total number of pulses applied to the channel a jack in the interval determined locally by the FUNCTION/RESOLUTION switch is displayed. Input pulses may be of any shape and duty cycle, and may be applied either at random or a constant repetition rate. The count mode can be used to measure quantities or rates. For example, if a transducer is used to generate a pulse for each person boarding a bus, the total number of people on the bus is counted.

The count mode can also be used for totalizing, because disabling counting does not reset the instrument, unless the RESET button is pressed, the count is retained in storage. Thus, if the instrument is not reset, and counting is reenabled, the new count will add to the stored count and the display will indicate the total of the two individual counts.

FREQ MODE:

In the FREQ mode, the average frequency of a signal applied to the CHANNEL A jack is measured. This is done by counting the input pulses over an interval determined by the internal time base. The time base is automatically varied to provide the maximum resolution for the applied signal. The maximum number of digits displayed is variable from 4 to 6 (4 to 8 optional) by the FUNCTION/RESOLUTION switch. Table 3-2 lists the positions of this switch and gives the corresponding readouts for a range of input frequencies.

PERIOD MODE:

In the PERIOD Mode, the period of a signal applied to the CHANNEL A jack is measured. This is done by counting the pulses produced by the internal time base over a single period of the input signal. The time base is automatically varied to provide the maximum resolution for the applied signal. The maximum number of digits displayed is variable from 4 to 6 (4 to 8 optional) by the FUNCTION/RESOLUTION switch. Table 3-3 lists the positions of this switch and gives the corresponding readouts for a range of input frequencies.

POSITIVE PULSEWIDTH AND NEGATIVE PULSEWIDTH MODES:

In the POSITIVE PULSEWIDTH and NEGATIVE PULSEWIDTH Modes, the pulses produced by the internal time base are counted over the period of the input signal.

PERIOD AVERAGE MODE:

In the PERIOD AVERAGE Mode, the average period of a signal applied to the CHANNEL A jack is measured. This is done by counting the pulses produced by the internal time base over from 1 to 10^3 periods of the input signal. The number of periods over which the frequency is averaged, is automatically selected to provide maximum resolution for the applied signal. Table 3-4 gives the 7-digit display readout, and the number of periods over which the frequency is averaged, for a range of input frequencies

TIME A→B MODE:

In the TIME A→B Mode, the pulses produced by the internal time base are counted over the interval between the supply of a start pulse to the INPUT A jack and the supply of a stop pulse to the INPUT B jack. One application for the TIME A→B Mode is the measurement of elapsed time between two signals. The TIME A→B Mode can also be used to measure the elapsed time between two selected points on a single waveform.

RATIO A/NB MODE:

In the RATIO A/NB Mode, the ratio of two frequencies can be measured. The source of one frequency is applied to the CHANNEL A jack and the source of the other frequency is applied to the CHANNEL B jack. Both jacks are located on the front panel. The measurement is made by counting the number of A pulses occuring in 1 to 10^3 periods of B. The number of periods over which the A pulses are counted is automatically selected to provide maximum resolution. This gives a readout of the ratio of frequency A to frequency B with automatic positioning of the decimal point. The frequency limits of the A and B inputs must be observed.

TIME-INTVL MODE:

In the TIME-INTVL Mode, the pulses produced by the internal time base are counted over the interval determined by the remote Count-Enable input. Counting is enabled when the input is a logic 0 and is inhibited when the input is a logic 1. Thus, if a square wave (varying between the logic levels) is applied to the Count-Enable input, the instrument indicates half the period of the waveform. Resetting is not automatic in the TIME-INTVL Mode. Unless the instrument is reset manually, the value obtained in the first interval will be stored and will add to the count obtained is subsequent intervals.

One application for the TIME-INTVL Mode is the measurement of elapsed time, where the Count-Enable input is switched to a logic 0 at the start of the interval and then switched back to a logic 1 at the end of the interval. Other applications include measurements of pulsewidth, duty cycle and time A to B where A and B are separate start/stop times.

REMOTE PROGRAMMING MODE:

In the REMOTE PROGRAMMING Mode, all functions may be remotely selected through pins on the optional rear-panel REMOTE PROG connector. The connector pin used for each function is given in Table 2-1.

Table 3-2. Frequency Measurement Data

INPUT FREQUENCY	SWITCH POSITION 4	5	6	7	8
10 MHz	10.00 MHz	10.000 MHz	10000.0 KHz	10000.00 KHz	010000.00 KHz
1 MHz	1.000 MHz	1000.0 KHz	1000.00 KHz	1000.000 KHz	01000.000 KHz
100 KHz	100.0 KHz	100.00 KHz	100.000 KHz	0100.000 KHz	00100.000 KHz
10 KHz	10.00 KHz	10.000 KHz	010.000 KHz	0010.000 KHz	00010.000 KHz
1 KHz	1.000 KHz	01.000 KHz	001.000 KHz	0001.000 KHz	00001.000 KHz
100 Hz	0.100 KHz	00.100 KHz	000.100 KHz	0000.100 KHz	00000.100 KHz
10 Hz	0.010 KHz	00.010 KHz	000.010 KHz	0000.010 KHz	00000.010 KHz

Table 3-3. Period Measurement Data

PERIOD OF INPUT SIGNAL	SWITCH POSITION 4	5	6	7	8
10 sec	10.00 sec	10.000 sec	10000.0 msec	10000.00 msec	10000.000 msec
1 sec	1.000 sec	1000.0 msec	1000.00 msec	1000.000 msec	1000000.0 μsec
100 msec	100.0 msec	100.00 msec	100.000 msec	100000.0 μsec	0100000.0 μsec
10 msec	10.00 msec	10.000 msec	10000.0 μsec	010000.0 μsec	0010000.0 μsec
1 msec	1.000 msec	1000.0 μsec	0100.0 μsec	001000.0 μsec	0001000.0 μsec
100 μsec	100.0 μsec	0100.0 μsec	00100.0 μsec	000100.0 μsec	0000100.0 μsec
10 μsec	010.0 μsec	0010.0 μsec	00010.0 μsec	000010.0 μsec	0000010.0 μsec
1 μsec	001.0 μsec	0001.0 μsec	00001.0 μsec	000001.0 μsec	0000001.0 μsec

Table 3-4. Period Average Measurement Data

PERIOD OF INPUT SIGNAL	NO. OF PERIODS AVERAGED	READOUT
1 sec	1	1000000 μsec
100 msec	10	100000.0 μsec
10 msec	100	10000.00 μsec
1 msec	1000	1000.000 μsec
100 μsec	1000	0100.000 μsec
10 μsec	1000	0010.000 μsec
1 μsec	1000	0001.000 μsec

3-4. INPUT CIRCUIT ADJUSTMENT

The input controls for both the A Channel and the B Channel are identical. The correct setting of these controls is of prime importance in order to obtain the best possible results.

The choice of ac or dc coupling depends on the type of signal to be measured. If the signal has a small ac component riding on a dc level, ac coupling should be used. For symmetrical signals, ac coupling is desirable. For very assymetrical signals like pulses with low duty cycle, dc coupling is preferable, particularly if the pulses are random. For waveforms below 1 KHz, the coupling selector switch should be set to HF REJ. This position attenuates signals above 1 KHz and will filter out noise superimposed on the input waveform.

Attenuation should be selected as required: X1 (±1 volt), X10 (±10 volts) or X100 (±100 volts). If the input signal is not known, begin with X100 attenuation and decrease as required.

The SLOPE switch selects whether the instrument triggers on the positive or negative going edge of the input waveform. For sinusoidal waveforms, the choice is usually arbitrary, but for other waveforms it is desirable to trigger on the steepest slope in order to minimize trigger error.

The TRIGGER LEVEL control sets the triggering point on the input waveform at any level between +1 and −1 volt. For input signals that cross ground level, the trigger level can be preset at zero crossover (ccw PSET). Integrated circuit logic levels are accomodated in the Ic position (cw).

For the correct input circuit adjustment proceed as follows:

a) Set the FUNCTION switch to COUNT START.
b) Connect a signal to the Channel A BNC connector.
c) Set the Coupling and SLOPE switches as explained above.
d) Set Step ATTENUATOR switch to X100 and rotate the Channel A TRIGGER LEVEL control from fully counter-clockwise to fully clockwise observing the points at which the counting stops. Decrease Step ATTENUATOR until proper counting is obtained through an angle of rotation of 45 degrees approximately.
e) Set the TRIGGER LEVEL control about midway between the 45 degree angle as outlined above.

During adjustment, the point of the waveform at which the counter is triggered may be observed on a high-input impedance oscilloscope connected to the A out pin on the rear panel.

The B Channel should be adjusted in the same way but in place of the display, an oscilloscope connected to B out on the rear should be used for the correct count observation.

NOTE

To minimize interchannel crosstalk due to high amplitude input signals in the TIME A→B and A/NB Modes of operation low impedance termination (50 ohms) should be connected to the BNC input connectors. Otherwise the input signals should be attenuated before its application to the counter's inputs.

3-5. PERFORMANCE TEST

The 5500A has a built-in test circuit that provides a confidence check of the instrument's operation. This circuit is used in the CHK Mode, which checks most of the circuitry in the instrument.

The performance of the 5500A should be checked upon receipt from the factory, after maintenance has been performed, and before each use.

1. Set the SEP-COM-CHK switch to the CHK position
2. Adjust both input circuits as outlined in paragraph 3-4
3. Set the FUNCTION switch to COUNT STOP
4. Press the RESET push-button and check that all digits display "0".
5. Set FUNCTION switch to COUNT START and check that the counter totalizes, overflows and the GATE light is on with the RESOLUTION switch set to 4,5,6,7 or 8 digits resolution.
6. Set FUNCTION switch to COUNT STOP. Check that the GATE light goes out and the display is held
7. Set FUNCTION switch to FREQ. The display should read:
   1.000 MHz with 4 digit resolution ±1 count
   1000.0 KHz with 5 digit resolution ±1 count
   1000.00 KHz with 6 digit resolution ±1 count
   1000.000 KHz with 7 digit resolution ±1 count
   1000.000 KHz with 8 digit resolution ± 1 count
8. Set FUNCTION switch to PERIOD. The display should read 1.0 μsec ±1 count.
9. Set FUNCTION switch to positive pulse mode. The display should read 0.5 μsec ±1 count. Note: slight readjustment of the Channel A TRIG LEVEL control may be necessary to obtain this reading.
10. Set FUNCTION switch to negative pulse mode. The display should read 0.5 μsec ±1 count. Note: slight readjustment of the Channel A TRIG LEVEL control may be necessary to obtain this reading.
11. Set FUNCTION switch to PERIOD AVG. The display should read 1.000 μsec ±1 count.
12. Set FUNCTION switch to TIME A→B. The display should read 1.0 μsec ±1 count with both switches set to positive or negative slopes, and 0.5 μsec ±1 count when the SLOPE switches are set to opposite polarity. Note: slight readjustment of Channel A TRIGGER LEVEL control may be necessary to obtain the readings
13. Set FUNCTION switch to A/NB. The display should read 1.000 ±1 count.
14. Set FUNCTION switch to TIME INTVL. Short pin 23 of the REMOTE PROG connector to ground (if option 02 is installed in this instrument) or short the two binding posts (when option 02 not installed). Observe for correct timing on the display which should only update when the connection to ground is made.

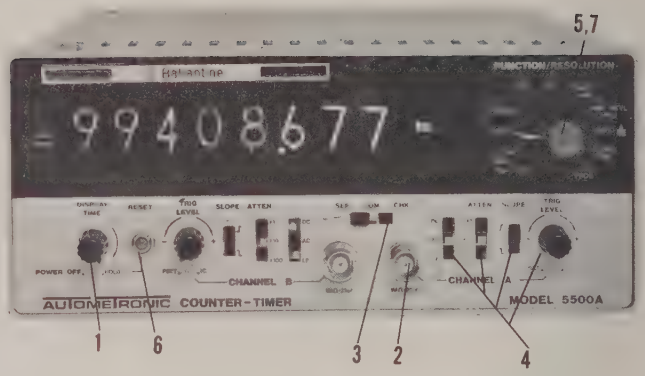
3-6. OPERATING PROCEDURES

Paragraphs 3-7 through 3-14 describe typical operating procedures.

Note that procedures presume 8 digit display and MOD 10 for 110 MHz. Substitute 6 digits and 90 MHz where only these limits are installed in your 5500A.

3-7. Operation in COUNT mode

1. Turn power switch on
2. Connect signal to be counted to the Channel A connector
3. Set SEP-COM-CHK switch to SEP
4. Adjust the Channel A input circuit as outlined in paragraph 3-4.
5. Set FUNCTION switch to COUNT STOP
6. Press RESET pushbutton
7. Start counting by setting the FUNCTION switch to COUNT START and stop by setting to COUNT STOP. Note: If the OVERRANGE indicator is lit, the count indicated is not the total count

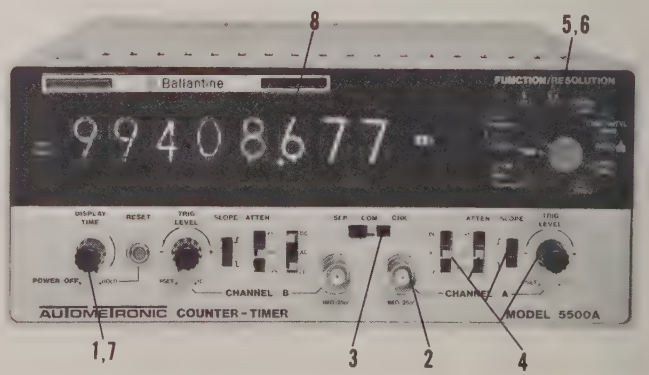


3-8. Operation in FREQ mode

1. Turn power switch on
2. Connect signal to be measured 0 to 110 MHz to the Channel A connector
3. Set SEP-COM-CHK switch to SEP
4. Adjust the Channel A input circuit as outlined in paragraph 3-4
5. Set FUNCTION switch to FREQ
6. Set RESOLUTION switch to required resolution
7. Adjust DISPLAY TIME control for convenient measurement interval
8. The display indicates the frequency of the input signal. The unit and decimal point is internally computed and displayed automatically.

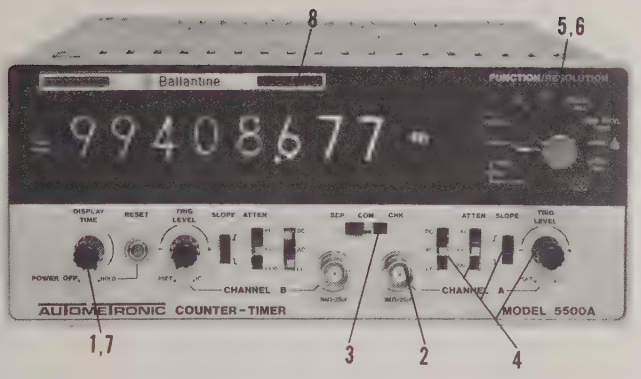
3-9. Operation in PERIOD mode

1. Turn power switch on
2. Connect signal to be measured (100 nsec to 10^8 seconds) to the Channel A connector
3. Set SEP-COM-CHK switch to SEP
4. Adjust the Channel A input circuit as outlined in paragraph 3-4
5. Set FUNCTION switch to PERIOD
6. Set the RESOLUTION switch to the required resolution
7. Adjust DISPLAY TIME control for convenient measurement interval
8. The display indicates the period of the input signal. The unit and decimal point is internally computed and displayed automatically



3-10. Operation in Positive Pulsewidth and Negative Pulsewidth modes

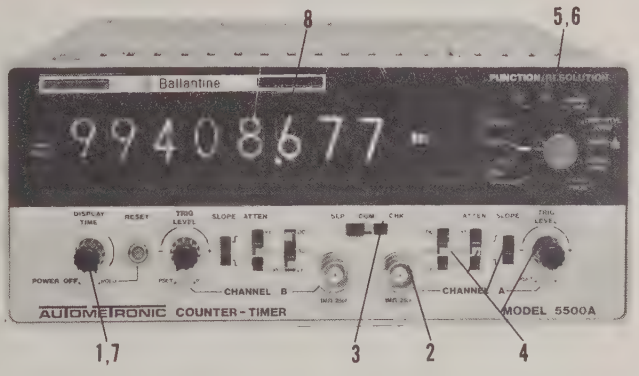
1. Turn power switch on
2. Connect signal to be measured (100 nsec to 10^8 seconds) to the Channel A connector
3. Set SEP-COM-CHK switch to SEP
4. Adjust the Channel A input circuit as outlined in paragraph 3-4
5. Set FUNCTION switch to positive pulsewidth or negative pulsewidth
6. Set RESOLUTION switch to the required resolution
7. Adjust DISPLAY TIME control for convenient measurement interval
8. The display indicates the width of the positive or negative pulse. The unit and decimal point is internally computed and displayed automatically



3-11. Operation in the PERIOD AVG mode

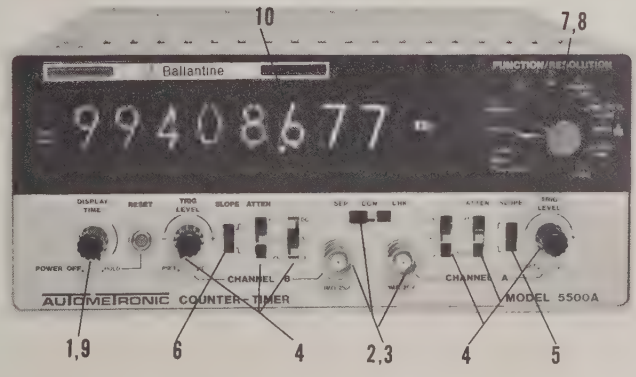
1. Turn power switch on
2. Connect signal to be measured (0.1 Hz to 1 MHz) to the Channel A connector
3. Set SEP-COM-CHK switch to SEP
4. Adjust the Channel A input circuit as outlined in paragraph 3-4
5. Set FUNCTION switch to PERIOD AVG
6. Set RESOLUTION switch to the required resolution
7. Adjust DISPLAY TIME control for convenient measurement interval
8. The display indicates the average period of the input signal in microseconds

   Note: In this mode, the display range may be exceeded if the minimum frequency of the input signal is less than:
   100 Hz with 4 digit resolution
   10 Hz with 5 digit resolution
   1 Hz with 6 digit resolution
   0.1 Hz with 7 digit resolution
   0.01 Hz with 8 digit resolution



3-12. Operation in Time A→B mode

1. Turn power switch on
2. If separate start and stop signals are to be used, set SEP-COM-CHK switch to SEP. Connect the start signal to Channel A connector and connect the stop signal to Channel B connector
3. If one signal is to be used to start and stop the count, set SEP-COM-CHK switch to COM. Connect the signal to Channel A connector
4. Adjust the Channel A and Channel B input circuits as outlined in paragraph 3-4
5. Set the Channel A SLOPE switch to start the count on the desired slope
6. Set the Channel B SLOPE switch to stop the count on the desired slope
7. Set FUNCTION switch to TIME A→B
8. Set RESOLUTION switch to required resolution
9. Adjust DISPLAY TIME control for convenient measurement interval
10. The display indicates the time interval between the start signal at Channel A and stop signal at Channel B. The unit and decimal point is internally computed and displayed automatically

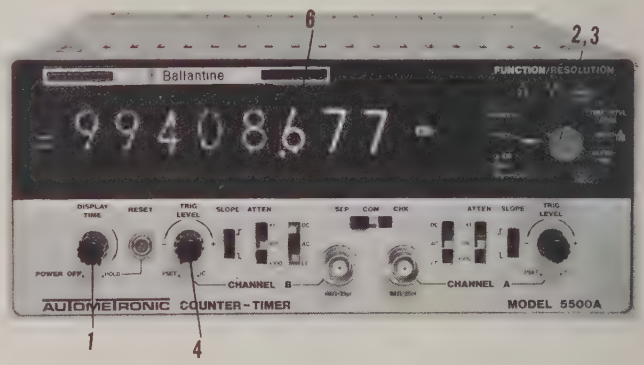


3-13. Operation in Ratio (A/NB) mode

1. Turn power switch on
2. Connect higher frequency input (DC to 110 MHz) to Channel A connector
3. Connect lower frequency input (DC to 10 MHz) to Channel B connector
4. Set SEP-COM-CHK switch to SEP
5. Adjust the Channel A and Channel B input circuits as outlined in paragraph 3-4
6. Set FUNCTION switch to A/NB
7. Set RESOLUTION switch to required resolution
8. Adjust DISPLAY TIME control for convenient measurement interval
9. The display indicates the ratio FA/FB with an automatically positioned decimal point

3-14. Operation in TIME INTVL mode

1. Turn power switch on
2. Set FUNCTION switch to TIME INTVL
3. Set RESOLUTION switch to required resolution
4. Press the RESET push-button to zero the display.
5. Short pin 23 of REMOTE PROG connector to ground, pin 24, (if option 02 is installed in this instrument) or short the two binding posts (option 02 not installed) to start the timing interval, and open the terminals to stop the timing interval. This action may be repeated as many times as required. An external switch or saturated transistor to ground may be used to automate or remotely control the Time Internal mode.
6. The display indicates the total time of operation while the connection of 5 above is made. The unit and the decimal point is internally computed and displayed automatically



Principles of Operation

4-1. INTRODUCTION

This section of the manual contains a description of the circuitry used in the 5500A. A simplified block diagram is given in Figure 4-1 followed by signal Flow-Diagrams for each mode of operation (Fig. 4-2 to Fig 4-9). Complete schematics of each circuit are given in Section 7. Refer to these diagrams throughout the following circuit description.

4-2. ASSEMBLY DESIGNATIONS

Table 4-1 lists the designations of the assemblies used in this instrument.

Table 4-1. Assembly Identification

ASSY	NAME
A1	Front Panel Assy
A2	Rear Panel Assy
A3	Main P.C. Board Assy
A4	Display P.C. Board Assy
A5	Input Circuits Assy
A6	Chassis Assy
A7	Interconnect

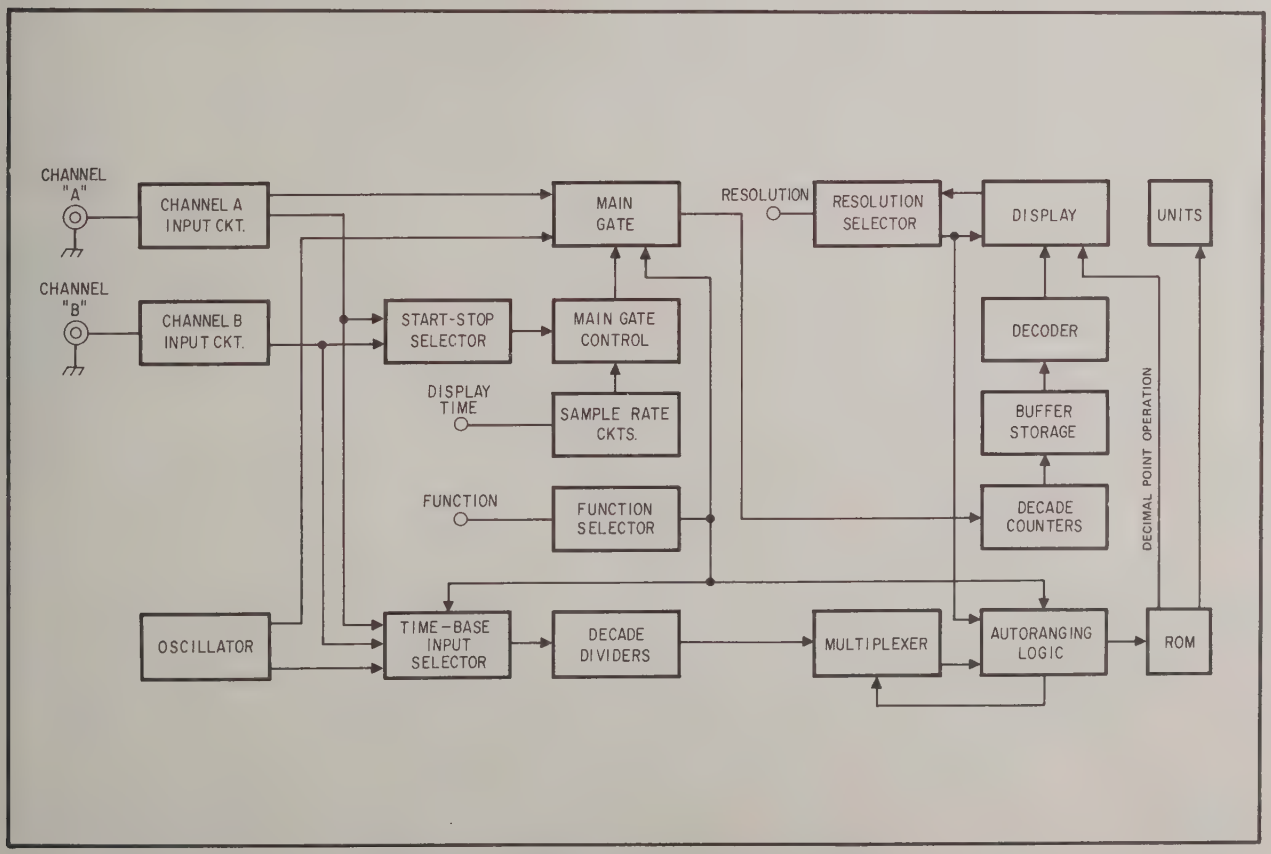


Figure 4-1. 5500A Simplified Block Diagram

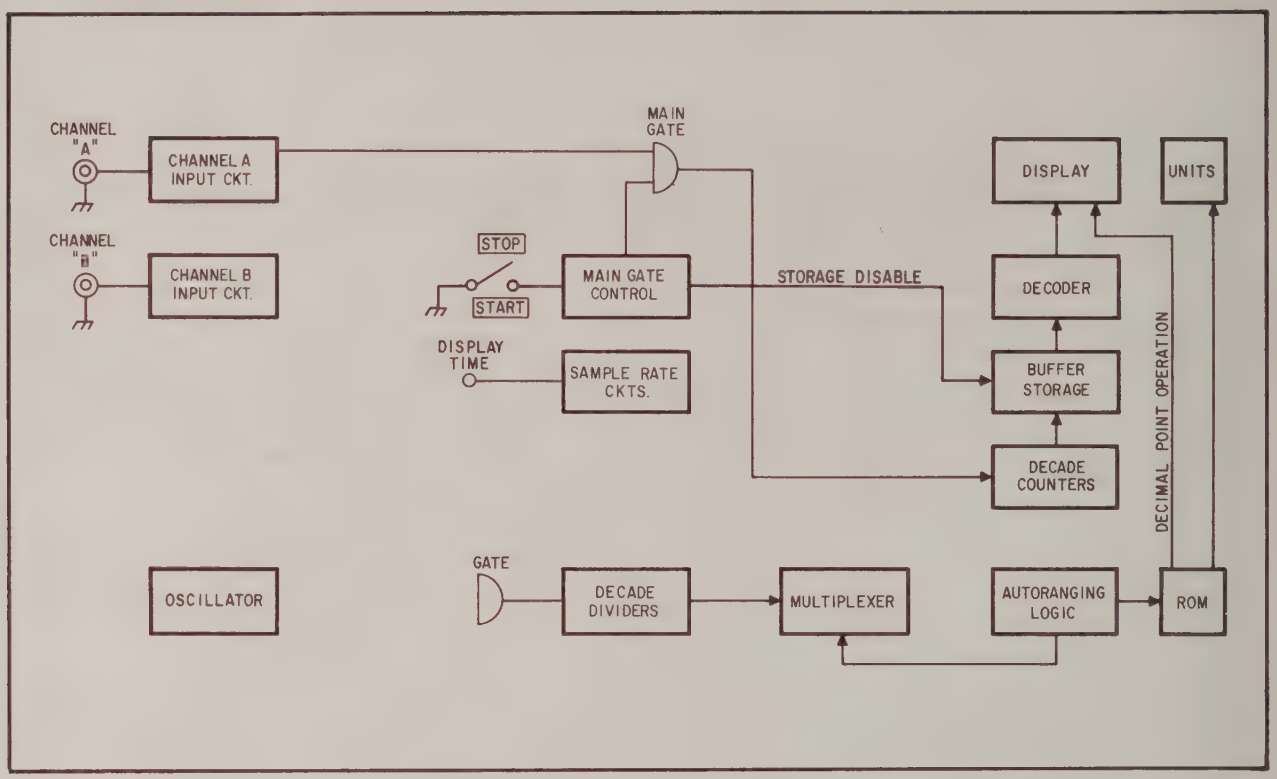


Figure 4-2. Count Mode Flow Diagram

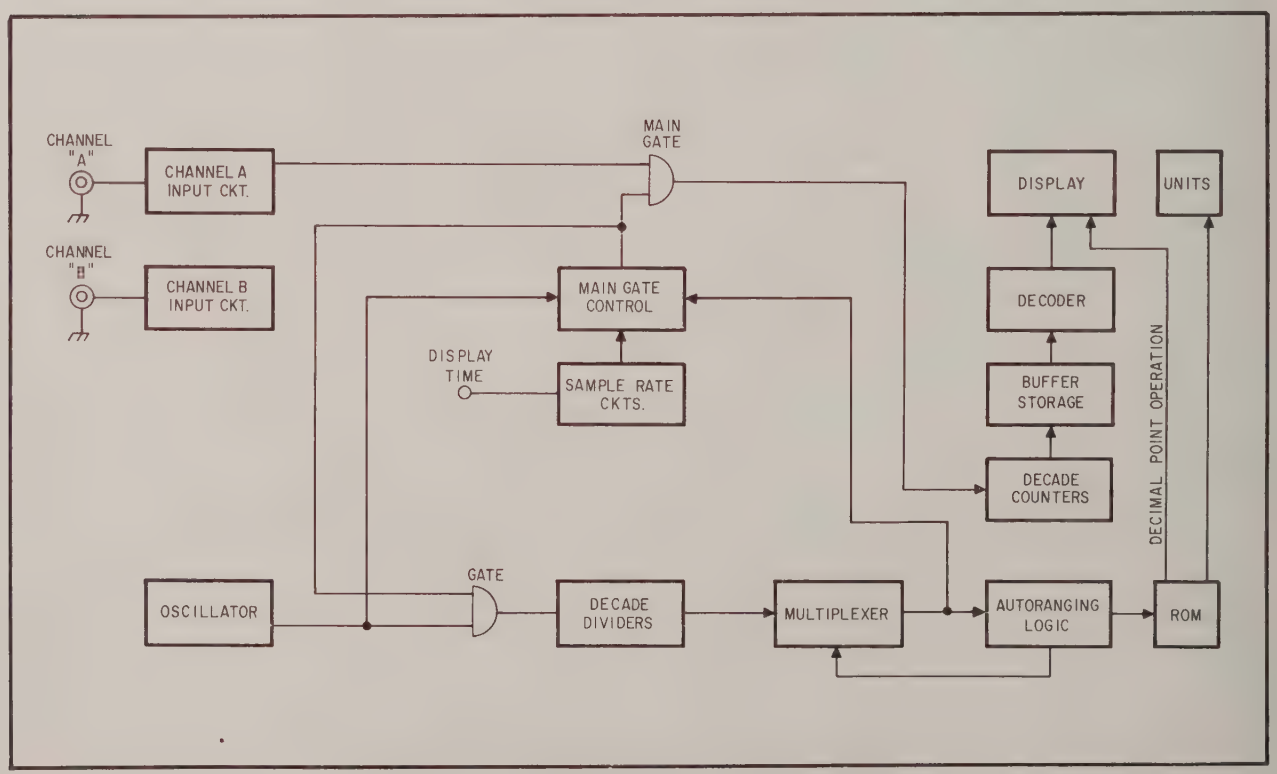


Figure 4-3. Frequency Mode Flow Diagram

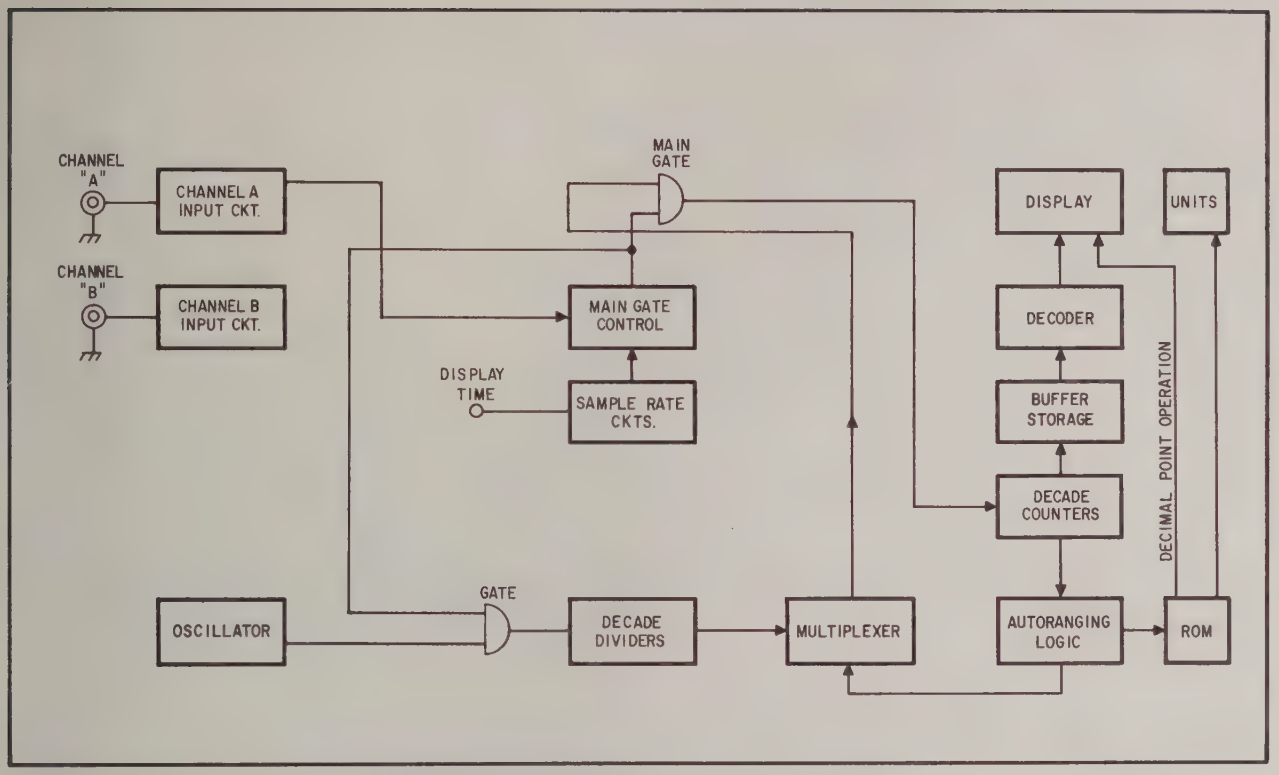


Figure 4-4. Period Mode Flow Diagram

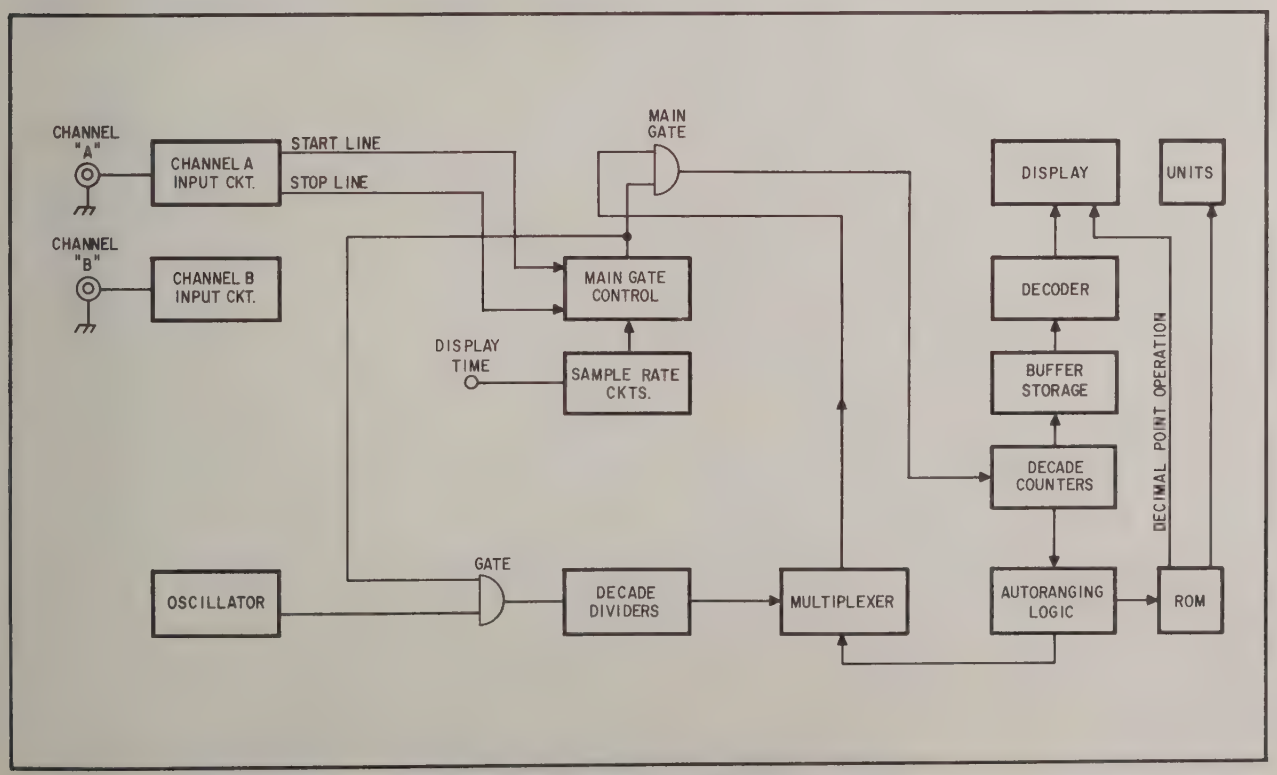


Figure 4-5. Positive or Negative Pulsewidth

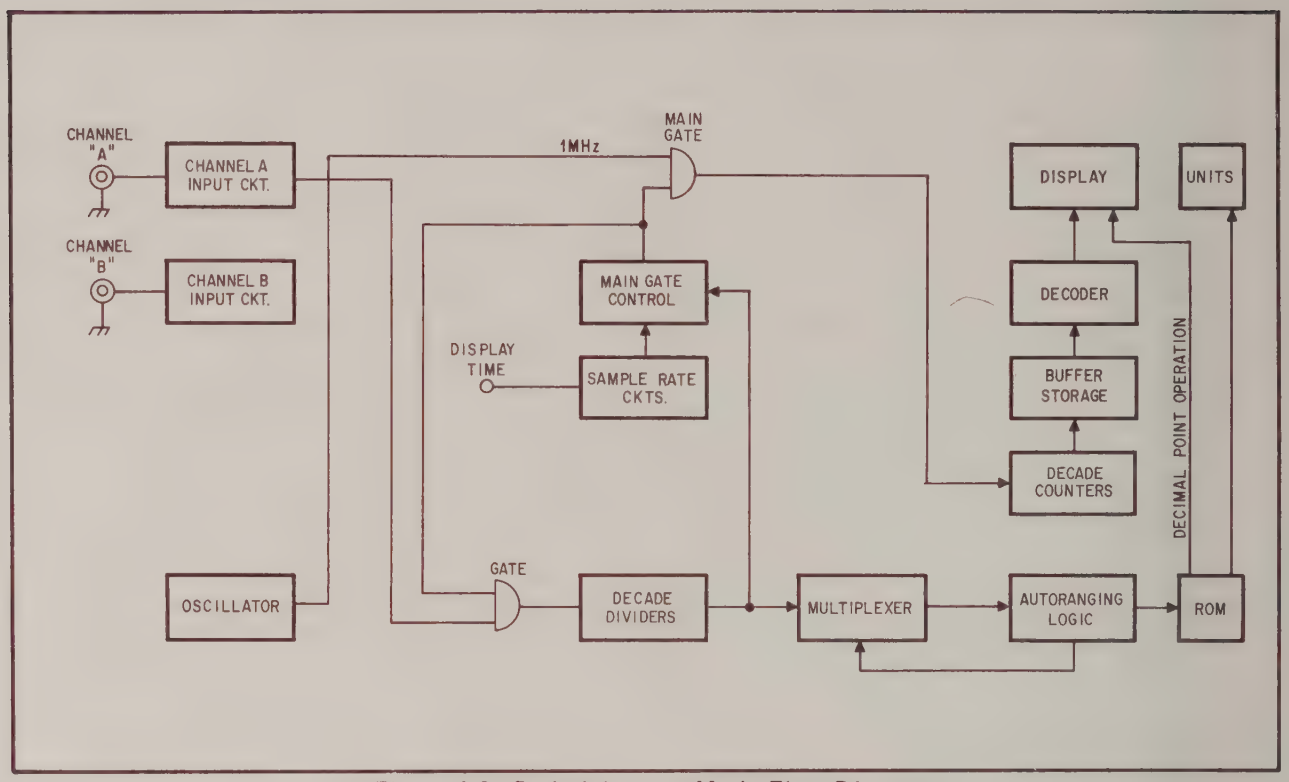


Figure 4-6. Period Average Mode Flow Diagram

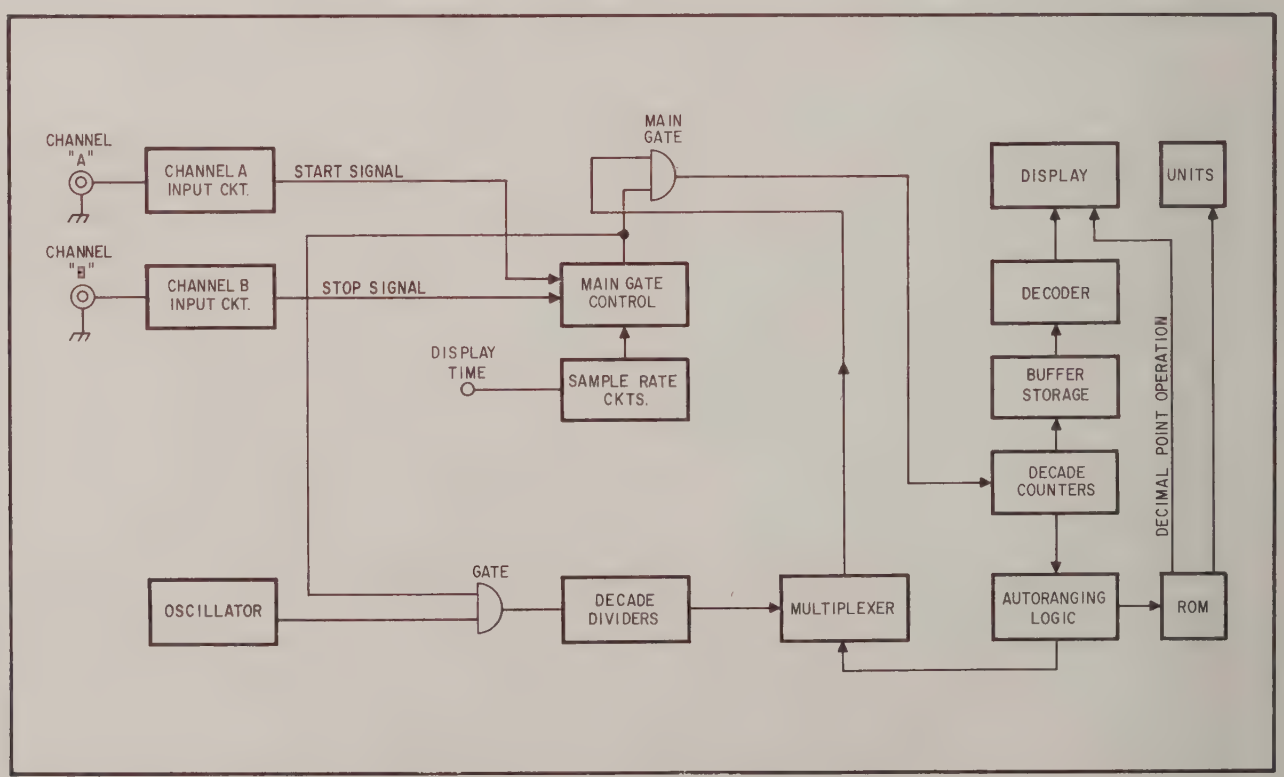


Figure 4-7. Time A→B Mode Flow Diagram

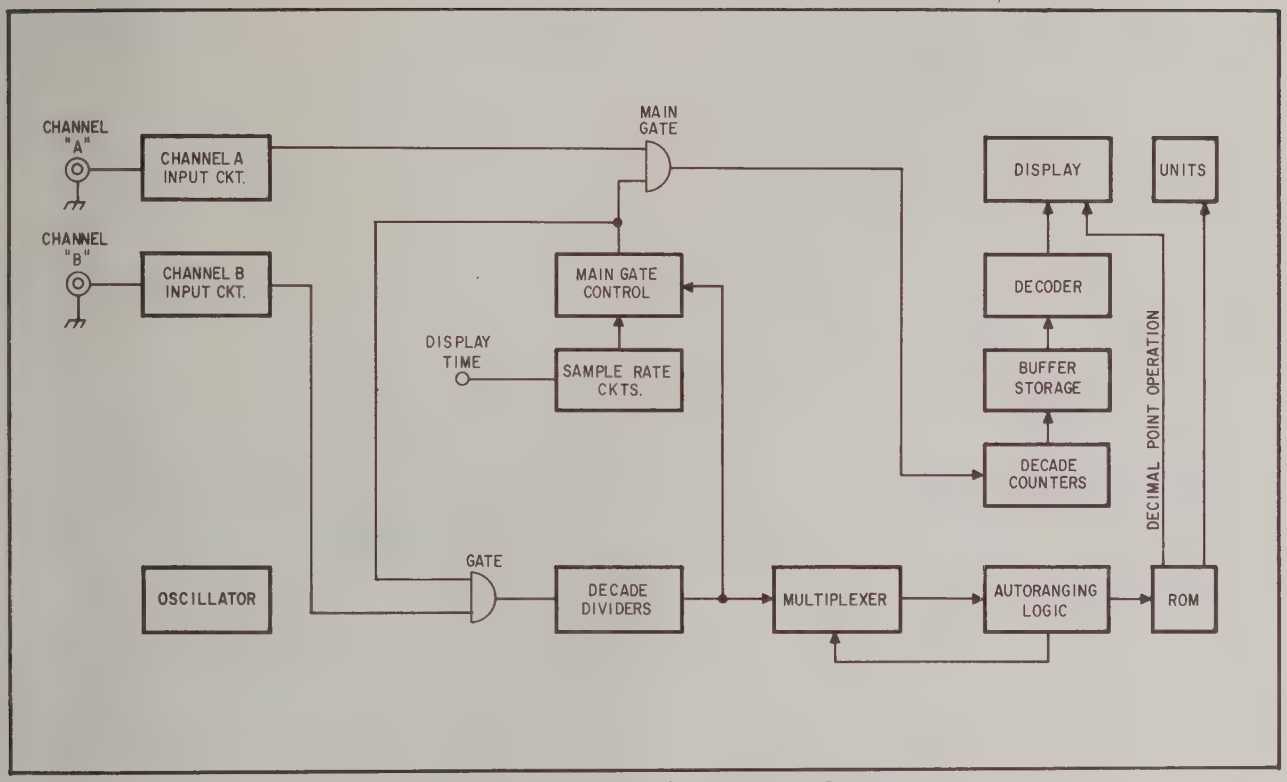


Figure 4-8. A/NB (Ratio) Mode Flow Diagram

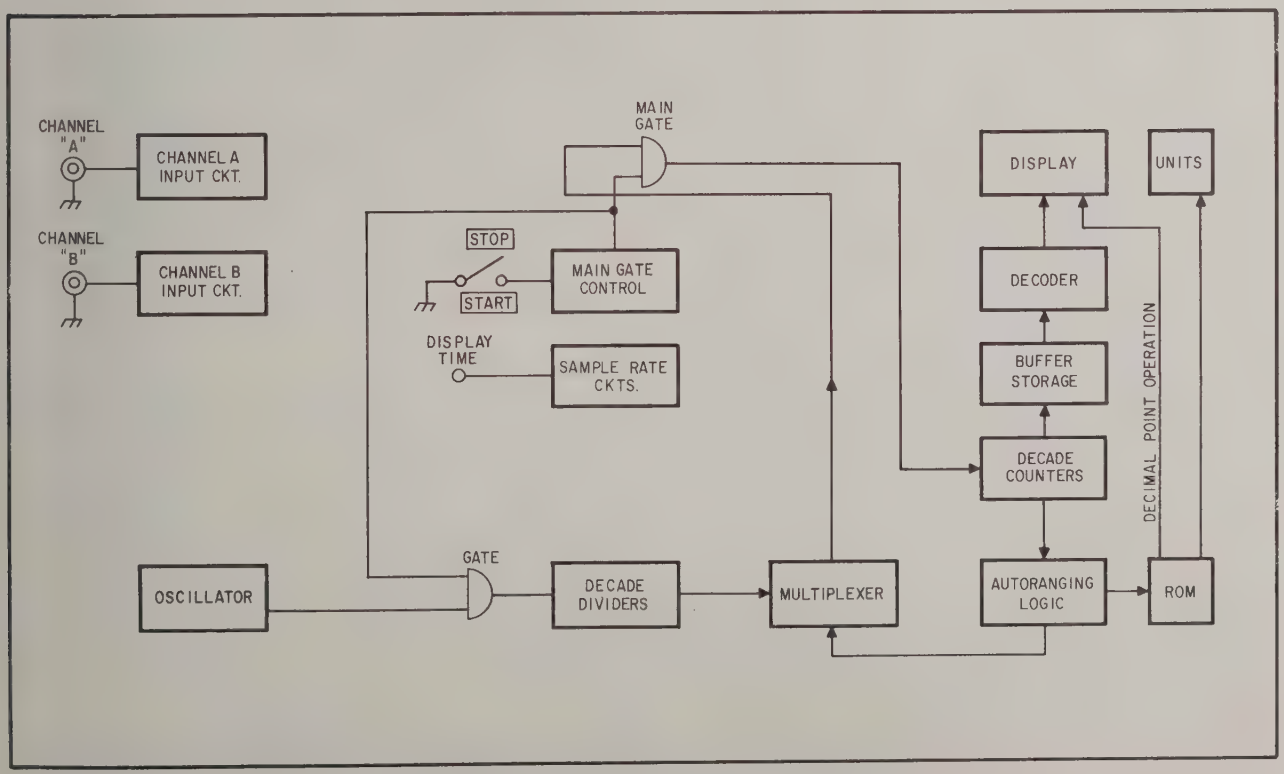


Figure 4-9. Time Interval Mode Flow Diagram

4-3. CHANNEL A INPUT CIRCUIT OPERATION

The 5500A has two input circuits, which are designated A and B. The Channel A input is used for all signal measurements. The B input is an auxiliary input and is used when measuring Time A→B and the ratio of two frequencies. Both circuits shape the input signal to provide well defined edges for proper triggering.

The Channel A input signals are routed through A1J1 to Coupling Selector A1S6. Depending on the switch setting, the signals are either directly coupled to Attenuator A1S5 (DC position) or taken via capacitor A1C1 (AC position). In the HF REJ position, capacitor A1C5 is connected to ground and causes signals above 1 kHz to be attenuated.

When Attenuator A1S5 is set to X1, the full input signal is fed via SEP-COM-CHK switch A1S13 to the gate of A5Q1A. With A1S5 set to X10 or X100, the appropriate voltage divider is selected. The SEP-COM-CHK switch connects inputs A and B in parallel when set to COM, and connects a 1 MHz test signal to the A and B input circuits when set to CHK.

The signal to A5Q1A and A5Q1B is limited by the diode-limiter A5CR1 and A5CR2. The limiter protects FET A5Q1A from overload. TRIG LEVEL control A1R9 selects the gate voltage of A5Q1B between −1 V and +1 V approx. and thereby determines the triggering level. Maximum sensitivity is obtained when the triggering voltage is about zero volts. This obtained when the TRIG LEVEL control is set to its mid position. A5R5 is a balance potentiometer which compensates for tolerances in the differential amplifier circuit.

The output of the differential amplifier is coupled via emitter followers A5Q4 and A5Q5 to the intergrated circuit amplifier and shaper A5U5. The shaped output is coupled to an ECL to TTL translator A5Q6, A5Q7 and A5Q8.

4-4. CHANNEL B INPUT CIRCUIT OPERATION

The Channel B input signals are routed through A1J2, Coupling Selector A1S7 and Attenuator A1S8 to the gate of A5Q9A. The Coupling Selector and Attenuator are identical to those in the Channel A input circuit. Transistors A5Q9A, A5Q9B, A5Q10 and A5Q11 with their associated circuitry form a differential amplifier whose output is fed to the input of the integrated circuit Schmitt Trigger (U4) which shapes the waveforms of the Channel B signal.

4-5. 10 MHz OSCILLATOR OPERATION

The 10 MHz oscillator consists of A3U9A acting as a positive feedback amplifier and A3U9B acting as a buffer. It forms a very stable crystal controlled oscillator, which can be adjusted to exactly 10 MHz by means of trimmer capacitors A3C4 for coarse frequency adjustment and A3C6 (accessible thru rear panel) for fine adjustments. The oscillator output is coupled to shaper A3U9C. Transistors A3Q1, A3Q2 and A3Q3 form an ECL to TTL translator.

4-6. EXT CLOCK IN / 1 MHz CLOCK OUT OPERATION

Connector A2J1 is used as an input point for an external clock and also for the output of an 1 MHz signal from the instrument. With the switch A2S1 set to 1 MHz CLOCK OUT, the 10 MHz internal clock is fed to the shaper A3U9C. The 1 MHz output from A3U1 is supplied to the circuitry of the instrument and to A2J1. When the switch is set to EXT CLOCK IN, the external clock input is fed to the shaper A3U9C. When externally triggered, the input to A3U9C is protected against overload by a pair of diodes A3CR3 and A3CR4.

4-7. CONTROL LOGIC OPERATION

The control logic determines the start and stop functions for the count being taken, controls the routing of input and time base signals, and the sequence of operation. The operation of the control logic will be described by an analysis of three of the operating modes.

Consider the operation of the circuitry in the COUNT mode. With FUNCTION switch A1S1 set to COUNT START, the inputs to Nand gates A3U14C and A3U14D are low. The outputs of both gates are therefore high. This level is inverted to a low at pin 6 of A3U14B. The high gate signal output from A3U14A enables main gate A5U1C contained on the input circuit board. Counting will continue until the FUNCTION switch is set at COUNT STOP.

With the FUNCTION switch set at FREQ position, ground is applied to Nand gate A3U19A and inverter A3U18C. The high at the output of A3U19A enables A3U16A and A3U2A, and the high at the output of A3U18C enables A3U8B. All the inputs to Nand gate A3U20B are high and the low at the output of the gate inhibits A3U16D. Main gate control flip-flops A3U15A and A3U15B are initially reset and the low at the Q output of A3U15B inhibits Nand gate A3U4C and enables Nand gates A3U4A and A3U8B. 1 MHz clock pulses are therefore routed through A3U8B, A3U8E, A3U16A, A3U16E, A3U6A and A3U6B to the clock input of D flip-flop A3U15B.

The first positive-going edge of the 1 MHz clock caused the Q output of A3U15B to adapt the state of the D input (i.e. logic high). In this state, all the inputs to A3U4C are high and the low at the output of the gate prevents subsequent 1 MHz clock pulses from reaching the clock input of A3U15B. The low at the Q output of A3U15B toggles A3U15A to the set state and makes the gate signal at the output of A3U14A go high.

While the gate signal is high, the output of the Channel A input circuit is routed to the first decade counter stage. Nand gate A3U13B is also enabled, allowing the 1 MHz clock pulses to be routed to the time base multiplexer. This circuit, together with the autoranging logic comprising Nand gates A3U2A, A3U2D and decade counter A3U12, produces a succession of pulses at decade intervals. These pulses are counted by the decade counter.

When the first four digits of the display have been filled (with RESOLUTION switch set to 5), or more exactly, when a count of 9900 is reached, the trigger input to J-K flip-flop A3U5A goes low and sets the flip-flop. When A3U5B is reset by the next pulse from the time base multiplexer, both inputs to Nand gate A3U17B are high and the low at its output sets flip-flop A3U4A, A3U4B. The low at the output of A3U4B is inverted to a high by A3U4C, which enables A3U6A. The next 1 MHz clock pulse is therefore routed to the clock input of A3U15B. Since its D input is low (because A3U15A is set) the positive going edge of the 1 MHz clock makes the Q output of A3U15B go low, thereby ending the count interval.

The autoranging circuit, together with the circuit in the display unit which detects when a count of 9900 is reached, automatically selects the optimum gate time for maximum resolution, whilst preventing the display capacity from being exceeded. The time base multiplexer provides all the necessary timing signals beginning with a start pulse to initiate the measurement. This is followed by a succession of valid stop pulse at decade intervals of 1 μsec, 10 μsec, 100 μsec and so on up to 1 sec. The first available stop pulse following the 9900 count is detected by J-K flip-flops A3U5A and A3U5B. The number of stop pulses counted by decade counter A3U12 before the display was filled determines the decimal point and unit information.

Operation is PERIOD mode is similar to operation in FREQ mode. However, in PERIOD mode the instrument counts the internal clock during one period of the input signal. Also, the decade counter in the autoranging circuit counts the "overflow" pulses from the most significant decade of the display unit, instead of the stop pulses from the time base multiplexer.

With the FUNCTION switch set at PERIOD, ground is applied to Nand gates A3U4C and A3U20B. The high at the output of A3U4C enables A3U6A, and the high at the output of A3U20B enables A3U16D, A3U17A and A3U8B. The low at the output of inverter A3U18B inhibits A5U1A in the input circuits board. The signal from the Channel A input circuit is routed through A5U1D, the Channel A slope selection circuit A3U16D, A3U16E, A3U6A and A3U6B to the clock input of D flip-flop A3U15B. The first positive going edge of the Channel A signal causes the Q output of A3U15B to go high. The low at the $\overline{Q}$ output sets A3U15A and makes the gate signal at the output of A3U14A to high.

The Channel A slope selection circuit comprises SLOPE switch A1S4, and gates A3U31A to A3U31D and N or gates A3U31E, F. The circuit determines whether counting occurs between positive or negative edges of the input signal. When the switch is set at positive slope, ground is applied to Nand gate A3U31D and therefore the negative going pulses from the input circuit are routed to the main gate control circuit.

When the gate signal goes high, 10 MHz clock pulses are routed through A3U8C, A3U8E and A3U13B to the time base multiplexer. The output is fed through A3U17A and A3U17C to A5U1 on the input circuit board. Since A5U1 is enabled, the internal clock is fed to the first decade counter stage. When the second positive-going edge of the Channel A signal appears, A3U15B changes state, thereby ending the count interval. The cycle is repeated when a reset pulse is generated.

While the instrument is counting, overflow pulses from the most significant decade are routed through A3U2C and A3U2D to decade counter A3U12. Until an "overflow" occurs, pulses at the highest time base frequency (0.1 μsec) are routed to the first counter stage. When an overflow occurs, the next lower time base frequency is selected (1 μsec). This process continues until the end of the count interval. The output of decade counter A3U12 provides the correct decimal point and unit indication.

4-8. SAMPLE RATE AND RESET CIRCUIT

In order to ensure sufficient time for a visual readout of the measurement, a Display Time control is provided at the front panel of the instrument. The purpose of this control is to provide a reset pulse for a selected time interval (0.2 to 5 seconds) after completion of a measurement. When the control is set to HOLD, the display is held indefinitely until the manual RESET pushbutton is depressed.

During the count interval, transistor A3Q7 is in saturation due to the high on its base from the main gate control circuit. At the end of the count interval, A3Q7 is cut-off and causes capacitor A3C35 to start to charge. When the voltage across the capacitor reaches the unijunction transistor A3Q9 firing voltage, a negative-going pulse is produced and supplied to the Reset Multivibrator, U30B and Q10. The output from A3Q10 resets the circuits in the instrument. A reset pulse can also be produced manually by operation of the RESET pushbutton A1S11. Setting of the DISPLAY TIME control to HOLD will cause the +15 V supply to be disconnected from the DISPLAY TIME control. Under this condition, A3C35 will not be charged and therefore no reset pulse will be generated.

The inhibit input is normally intended for use with an external digital printer, but if necessary it can also be used independently to provide an external form of display control. A high level at A2J2-22 will saturate A3Q8 and thereby inhibit the generation of a reset pulse.

4-9. GATE INDICATOR, TRANSFER PRINT COMMAND CIRCUITS

The gate indicator circuit controls the lighting of the GATE lamp. The output of Nand gate A3U14A, which is high during the count interval, is supplied through inverter A3U6C to Nand gate A3U28A and the pulse stretcher comprising A3U28B and A3U28D. The output of A3U28A is supplied to the display circuit for controlling the lighting of the GATE indicator. For short count intervals the pulse stretches causes the GATE lamp to light for a longer interval, enabling it to be visible even when the count interval is very short.

The transfer circuit generates a positive-going pulse which transfers the content of the counting circuits to the storage and display units. The circuit also controls the transfer of decimal point and units information. The transfer pulse is generated automatically at the end of the count interval.

The print command circuit produces a positive-going pulse that instructs a digital printer to record the BCD information from the display circuits. The circuit comprises monostable U30A, U32C and transistor A3Q5.

4-10. DISPLAY CIRCUIT

The display circuit consists of seven decimal/BCD counter latch circuits and BCD/decimal decoders which drive numeric display tubes. The display circuit contains also a coincidence circuit, a resolution selection circuit and circuits for lighting the decimal points in the display tubes and for lighting the GATE, OVERRANGE and units indicators.

The 10^0 decimal counter comprises Shottky flip-flops U2 U3, which are contained on the input circuits board. It counts the signal on the count line and when it reaches a count of 10, it produces a carry pulse which is counted by the 10^1 decimal/BCD counter. The 10^1 counter drives the 10^2 counter, etc., in a similar manner.

The BCD output of the counters is stored by the latch circuits. With a logic "0" at the transfer terminals, the previous count is displayed. When a logic "1" appears, the count is transfered to the decoders.

Nand gate U2 is used to detect when a count of 999900 is reached. When this occurs, all the inputs to the gate are high and therefore the output goes low. This level causes the autoranging logic to select the first available stop pulse and thus end the gate time.

The number of stop pulses counted by the autoranging logic determines the decimal point and units display.

RESOLUTION switch A1S2 serves several functions. Its main function is to select the number of display digits required. +200 is routed through the slider of wafer A to the anode of DS5 in position 5, to the anode of DS6 in position 6, and to the anode of DS7 in position 7. The anodes of DS1 to DS4 are connected permanently to +200 V.

The RESOLUTION switch is also used to route an overflow pulse from the most significant decade to the autoranging logic (timing modes) and to flip-flop U1C U1D (all modes). The logic level applied to the slider of wafer B is controlled by transistor A3Q6 and FUNCTION switch A1S1.

4-11. POWER SUPPLY

The power supply provides +200 V, ±15 V and +5 V. The instrument may be operated from a 115 volt or 230 volt ac source. Switch A2S3 provides the proper power transformer connection according to the source used.

The +200 V output is unregulated and is the supply voltage for the display tubes.

The +15 V output is regulated and is one of the supply voltages for the input circuit. A3Q17 is a series power transistor and A3U33 provides a constant reference voltage.

The +5 V output is the supply voltage for all of the micrologic. A6Q1 is the series regulator and is driven by the emitter follower A3Q14.

The −15 V output is regulated and is one of the supply voltages for the input circuit. A3Q11 and A3Q15 perform the same function as A3Q14 and A6Q1 in the +5 V supply. A3Q12 and A3Q13 form a differential amplifier to amplify the error voltage on the base of A3Q13.

Maintenance and Calibration

5-1. INTRODUCTION

This section provides maintenance, calibration and service information for the 5500A. Included are a table of recommended test equipment, input circuits adjustment, oscillator frequency adjustment and in-cabinet performance check which may be used to verify proper operation of the counter.

5-2. TEST EQUIPMENT

Recommended test equipment for troubleshooting, alignment and performance checking is listed in Table 5-1. Test instruments other than those listed may be used if their specifications equal or exceed the required characteristics.

5-3. INSTRUMENT COVER REMOVAL

To remove the top or bottom cover, unlock four quarter turn fasteners which secure cover to instrument. Then slide cover towards the top of instrument. To replace cover, reverse procedure.

WARNING

115/230 VAC and DC supply wires are exposed when either cover is removed. Disconnect the power cord while removing the covers.

5-4. CLEANING

The 5500A should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation.

Thoroughly clean both the inside and outside of the instrument. Remove dust from inaccessible areas with low pressure compressed air or vacuum cleaner. Use alcohol applied with a cleaning brush to remove accumulations of dirt or grease from connector contacts and component terminals. Clean the exterior of the instrument and the front panel with a mild detergent mixed with water, applying the solution with a soft, lint-free cloth.

5-5. VISUAL INSPECTION

The 5500A should be inspected occasionally for such defects as broken connections, loose, broken or frayed wiring, dirty or pitted switch and connector contacts and cracked or broken printed circuit boards. Often, before a total or partial failure occurs, a deteriorating component can be located due to obvious discoloration, cracking or care must be taken if heat-damaged parts are located. Overheating is usually only a symptom of trouble. For this reason, it is essential to determine the actual cause of overheating before the heat-damaged part is replaced, otherwise, the damage may be repeated.

5-6. REPAIR AND REPLACEMENT

Repair and replacement of electrical and mechanical parts must be accomplished with due exercise of caution. Printed circuit component boards can become warped, cracked or burnt from excessive heat or mechanical stress. The following repair techniques are suggested to avoid inadvertant destruction or degradation of parts and assemblies.

Use ordinary 60/40 solder and a 35 to 40-watt pencil type soldering iron on the circuit board. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the circuit from the base material. To desolder components use a commerical "solder sipper".

Always replace a component with its exact duplicate as specified in the parts list.

5-7. CHANNEL A INPUT CIRCUIT ADJUSTMENT

a. Connect a 50 kHz sinewave signal, 40 mV p-p, to the Channel A input.
b. Set TRIG LEVEL to the PSET position.
c. Connect oscilloscope probe to pin 9 of U1.
d. Adjust trimpot R5 for maximum symmetry.
e. Slight readjustment might be necessary at the highest frequencies for best result.

Table 5-1. Recommended Test Equipment

REQUIREMENT	INSTRUMENT OR EQUIVALENT
50 kHz to 100 MHz, 5 mV to 5 V constant amplitude sinewave generator	Tektronix Type 191 Signal Generator
10 Hz to 10 MHz sinewave generator	HP Model 651A
Oscilloscope having dc to 40 MHz minimum bandwidth. Dual Trace	Ballantine 1040A
Oscilloscope 15 MHz	Ballantine 1066A
Pulse Generator, 10 HZ to 50 MHz	EH Model G 710
1 MHz Frequency Standard	HP Model 105A/B
True RMS Voltmeter	Ballantine 323
Optional — Calibrator	Ballantine 6125A

Table 5-2. Frequency Mode Performance Check

NO	RESOLUTION SWITCH	INPUT AMPLITUDE mV rms	mV p-p	FREQUENCY	READING
1	4	100	280	90(110) MHz	90.00 MHz (110.00 MHz)
2	5	100	280	90(110) MHz	90.000 MHz (110.000 MHz)
3	6	100	280	90(110) MHz	90000.0 KHz (110000.0 KHz)
4	7	100	280	90(110) MHz	90000.00 KHz (110000.0 KHz)
5	8	100	280	90(110) MHz	90000.000 KHz (110000.00 KHz)
6	4	50	140	10 MHz	10.00 MHz
7	5	50	140	10 MHz	10.000 MHz
8	6	50	140	10 MHz	10000.0 KHz
9	7	50	140	10 MHz	10000.00 KHz
10	8	50	140	10 MHz	10000.000 KHz
11	4	25	70	1 MHz	1.000 MHz
12	5	25	70	1 MHz	1000.0 KHz
13	6	25	70	1 MHz	1000.00 KHz
14	7	25	70	1 MHz	1000.000 KHz
15	8	25	70	1 MHz	01000.00 KHz
16	4	25	70	100 KHz	100.0 KHz
17	5	25	70	100 KHz	100.00 KHz
18	6	25	70	100 KHz	100.000 KHz
19	7	25	70	100 KHz	0100.00 KHz
20	8	25	70	100 KHz	00100.00 KHz
21	4	25	70	10 KHz	10.00 KHz
22	5	25	70	10 KHz	10.000 KHz
23	6	25	70	10 KHz	010.000 KHz
24	7	25	70	10 KHz	0010.000 KHz
25	8	25	70	10 KHz	00010.00 KHz
26	4	25	70	1 KHz	1.000 KHz
27	5	25	70	1 KHz	01.000 KHz
28	6	25	70	1 KHz	001.000 KHz
29	7	25	70	1 KHz	0001.000 KHz
30	8	25	70	1 KHz	00001.00 KHz
31	4	25	70	100 Hz	0.100 KHz
32	5	25	70	100 Hz	00.100 KHz
33	6	25	70	100 Hz	000.100 KHz
34	7	25	70	100 Hz	0000.100 KHz
35	8	25	70	100 Hz	00000.100 KHz
36	1 sec	25	70	100 Hz	00000.100 KHz

5-8. CHANNEL B INPUT CIRCUIT ADJUSTMENT

a. Connect a 1 MHz sinewave signal, 40 mV p-p, to the Channel B input.
b. Connect probe of oscilloscope to pin 7 of IC4.
c. Set TRIG LEVEL control to the PSET position.
d. Adjust trimpot R41 for maximum symmetry.

5-9. TROUBLESHOOTING BY SELF-CHECK

When malfunction is suspected, disconnect all equipment from counter and perform self-check procedure given in Section 3. If counter does not self-check properly, refer to Section 4, Principles of Operation, for information on the operation of the circuits. If the counter self-checks properly, check that all inputs to counter are within the limits of specifications. If malfunction still occurs, cause is internal to counter. Make performance checks (par. 5-10) to help determine the source of trouble.

5-10. IN-CABINET PERFORMANCE CHECK

The following performance verifies proper operation of all circuits in the 5500A and may be used:

a. As part of an incoming inspection check of instrument specifications.
b. Periodically, for instruments used in systems.
c. As part of troubleshooting procedure.
d. After any repairs or adjustments, before returning instrument to regular service.

5-10-1. Count Mode (Channel A)

1. Set TRIG LEVEL control to PSET.
2. Set SEP-COM-CHK switch to SEP.
3. Set DC-AC-HF REJ switch to DC.
4. Set ATTEN switch to X1.
5. Connect sinewave signal 5 Hz to 1 MHz, 0.5 V p-p approx to BNC input connector.
6. Press the RESET pushbutton.
7. Set FUNCTION switch to COUNT START.
8. Vary the frequency from 5 Hz to 1 MHz and verify correct counting for each digit separately.
9. Check the OVERRANGE indicator is operated when the counter capacity is exceeded for 4, 5, 6 or 7 digits resolution.
10. Set FUNCTION switch to COUNT STOP. Check that the count stops and the reading is hold.

5-10-2. Frequency Mode (Channel A)

1. Set FUNCTION switch to FREQ.
2. Set DC-AC-HF REJ switch to DC.
3. Set SEP-COM-CHK switch to SEP.
4. Set ATTEN switch to X1.
5. Adjust Input Circuit as per Section 3, par. 3-4.
6. Check the instrument according to Table 5-2. The exact input frequency is not important. Check for stable readings. The input BNC connector should be terminated into 50 ohms.

5-10-3. Period Mode (Channel A)

1. Set FUNCTION switch to PERIOD.
2. Set DC-AC-HF REJ switch to DC.
3. Set SEP-COM-CHK switch to SEP.
4. Set ATTEN switch to X1.
5. Adjust Input Circuit as per Section 3, par. 3-4, with a 100 nano-second pulse, 0.5 V amplitude and rate of 1 KHz approx. The input BNC connector should be terminated into 50 ohms.
6. Check the instrument according to Table 5-3. The exact input period is not important. Check for stable readings.

5-10-4. Positive and Negative Pulse Modes (Channel A)

1. Set FUNCTION switch to positive pulse.
2. Set DC-AC-HF REJ switch to DC.
3. Set SEP-COM-CHK switch to SEP.
4. Set ATTEN switch to X1.
5. Adjust input circuit as per Section 3 with a 20 μsec positive pulse and 1:4 duty ratio and 0.5 V amplitude.
6. Check for a reading of 20 μsec with the FUNCTION switch set to positive pulse and 80 μsec when set to negative pulse. Verify that the slope switches do not influence the readings.

5-10-5. Period Average Mode (Channel A)

1. Set FUNCTION switch to PERIOD AVG.
2. Set DC-AC-HF REJ switch to DC.
3. Set SEP-COM-CHK switch to SEP.
4. Set ATTEN switch to X1.
5. Set TRIG LEVEL control to PSET.
6. Connect sinewave signal 5 Hz to 1 MHz, 0.5 V p-p, to BNC input connector.
7. Check the instrument according to Table 5-4.
8. Check 10 Hz (100 msec) signal with 4 digit resolution. Verify that the OVERRANGE indicator lights up.

5-10-6. Time A→B Mode

1. Set FUNCTION switch to TIME A→B.
2. Set DC-AC-HF REJ switch to DC (Channel A).
3. Set SEP-COM-CHK switch to SEP.
4. Set ATTEN switch to X1.
5. Set the DISPLAY TIME control to about midway.
6. Set the SLOPE switches of Channels A and B according to Table 5-5. Verify the opening of the counter gate while rotating the Channel A TRIG LEVEL control from fully clockwise (+) to fully anticlockwise (−), or the opposite, and the closure of the gate, in the same way for Channel B.
7. Set SEP-COM-CHK switch to COM.
8. Adjust input circuit as per Section 3, par. 3-4, with a 20 μsec positive pulse and 1:4 duty ratio and 0.5 V amplitude.
9. Set SLOPE switches of Channels A and B according to Table 5-6 and verify the correct readings.

Table 5-3. Period Mode Performance Check

NO	RESOLUTION SWITCH	RATE	PERIOD	READING
1	4	0.1 Hz	10 sec	10.00 sec
2	5	0.1 Hz	10 sec	10.000 sec
3	6	0.1 Hz	10 sec	10000.0 msec
4	7	0.1 Hz	10 sec	10000.00 msec
5	4	1 Hz	1 sec	1.000 sec
6	5	1 Hz	1 sec	1000.0 msec
7	6	1 Hz	1 sec	1000.00 msec
8	7	1 Hz	1 sec	1000.000 msec
9	4	10 Hz	0.1 sec	100.0 msec
10	5	10 Hz	0.1 sec	100.00 msec
11	6	10 Hz	0.1 sec	100.000 msec
12	7	10 Hz	0.1 sec	100000.0 μsec
13	4	100 Hz	10 msec	10.00 msec
14	5	100 Hz	10 msec	10.000 msec
15	6	100 Hz	10 msec	10000.0 μsec
16	7	100 Hz	10 msec	010000.0 μsec
17	4	1 KHz	1 msec	1.000 msec
18	5	1 KHz	1 msec	1000.0 μsec
19	6	1 KHz	1 msec	01000.0 μsec
20	7	1 KHz	1 msec	001000.0 μsec
21	4	10 KHz	100 μsec	100.0 μsec
22	5	10 KHz	100 μsec	0100.0 μsec
23	6	10 KHz	100 μsec	00100.0 μsec
24	7	10 KHz	100 μsec	000100.0 μsec
25	4	100 KHz	10 μsec	010.0 μsec
26	5	100 KHz	10 μsec	0010.0 μsec
27	6	100 KHz	10 μsec	00010.0 μsec
28	7	100 KHz	10 μsec	000010.0 μsec
29	4	1 MHz	1 μsec	001.0 μsec
30	4	3.3 MHz	0.3 μsec	000.3 μsec

5-10-7. A/NB (Ratio) Mode

1. Set FUNCTION switch to A/NB.
2. Connect internal oscillator output from rear panel BNC (1 MHz) to Channel A input. Adjust input circuit as per par. 3-4.
3. Set SEP-COM-CHK switch to SEP.
4. Connect sinewave oscillator to Channel B input. Adjust input circuit as per par. 3-4. Terminate into 50 ohms.
5. Check the instrument according to Table 5-7. The exact input frequency of Channel B is not important. Check for stable readings.

5-10-8. Time-Interval Mode

1. Set FUNCTION switch to TIME INTVL.
2. Shorten the REMOTE PROG jacks on the rear panel to start timing, and open to stop. For instruments equiped with Option 02 (Remote Programming), short pins 23 and 24 to start timing, and open to stop.
3. Observe correct timing and operation of the GATE indicator.

5-11. OSCILLATOR CALIBRATION

1. Trigger the oscilloscope from 1 MHz (Table 5-1) Frequency standard.
2. Observe 1 MHz signal from 1 MHz CLOCK OUT BNC on the rear panel of the 5500A on the vertical axis of the scope.
3. Adjust OSC ADJ trimmer on the rear panel of the 5500A with a plastic screwdriver until pattern on the oscilloscope stops drifting. It is important that this adjustment is made after at least 24 hours of continuous operation of the 5500A.

NOTE

NBS WWV standard ratio transmissions may also be used with a phase comparator system. Monitoring with a chart recorder is a good technique.

Instead of scope timebase triggering an X-Y lissajous figure is also recommended to observe proper 5500A clock frequency adjust.

Table 5-4. Period Average Performance Check

NO	RESOLUTION SWITCH	RATE	PERIOD	READING
1	4	1 MHz	1 μsec	1.000 μsec
2	4	100 KHz	10 μsec	10.00 μsec
3	4	10 KHz	100 μsec	100.0 μsec
4	4	1 KHz	1 msec	1000 μsec
5	5	100 Hz	10 msec	10000 μsec
6	6	10 Hz	100 msec	100000 μsec
7	7	5 Hz	0.2 sec	0200000 μsec

Table 5-5. Time A→B Performance Check

SLOPE A	SLOPE B	A TRIG LEVEL From → to	B TRIG LEVEL From → to
Pos Slope	Pos Slope	+ → −	+ → −
Pos Slope	Neg Slope	+ → −	− → +
Neg Slope	Neg Slope	− → +	− → +
Neg Slope	Pos Slope	− → +	+ → −

Table 5-6. Time A→B, Slope Selection Check

SLOPE A	SLOPE B	READING
Pos Slope	Pos Slope	100.0 μsec
Pos Slope	Neg Slope	020.0 μsec
Neg Slope	Neg Slope	100.0 μsec
Neg Slope	Pos Slope	080.0 μsec

Table 5-7. A/NB Ratio Mode

NO	RESOLUTION	CHANNEL B FREQUENCY	AMPLITUDE mV p-p	READING
1	4	10 MHz	130	0.100
2	4	1 MHz	60	1.000
3	4	100 KHz	60	10.00
4	4	10 KHz	60	100.0
5	4	1 KHz	60	1000
6	5	100 Hz	60	10000
7	6	10 Hz	60	100000

CAUTION

To remove knobs simply pry off the end button of the knob. Hold the knob firmly with your fingers or a padded tool and use a screwdriver to loosen the clutch device holding the knob to the shaft.

Do not loosen or tighten knob clutch by bearing against the end rotational stop of switches and potentiometers — always grasp the knob body firmly.

5-12. PACKING

The 5500A is a rugged instrument built to perform in severe environments. If the unit is to be shipped or stored for long periods of time the following packing procedure is recommended:

a) Place the 5500A into an oversize plastic bag and seal the bag.

b) Place the bagged 5500A into a heavy duty corrugated cardboard box. The box must contain at least 2 inches of rubberized hair or equivalent cushion on all six sides of the instrument. The counter must fit snugly into the cushion and the cushion must fit into the box to prevent any movement of the instrument in transit.

c) Place the instruction manual into the box. If accessories are also to be packed put them into a separate plastic bag and pack into the cushion leaving at least two inches of cushion between the instrument and the accessories as well as an extra cushion between accessories and the box.

d) Seal the box fully with 2 or 3 inch wide packing tape.

e) Properly label and address outside of box with a typed label or an indelible pen.

If shipment is to the factory, notify Ballantine in advance and include detailed reasons for return inside box along with your name, firm and full mailing address. Also include your phone number and purchase order number.

Ship prepaid by United Parcel Service or Registered Air Parcel Post to:

Ballantine Laboratories
90 Fanny Road
Post Office Box 97
Boonton, NJ USA 07005

Notes

Parts List

Section 6

The replacement parts listed are available from the vendors listed or from Ballantine Labs. at the address shown above. Your local Ballantine Field Engineering Representative may also carry a stock of parts and can assist you. If pricing quotations are required for parts and or repairs your local representative will give the most rapid service or you may contact the Ballantine Factory directly.

When ordering replacement parts always give the following information:

a) Instrument Model number
b) Serial number
c) Ballantine Part number
d) Schematic Symbol number
e) Identification of the part

Ballantine will do its best to improve the instrument and may make changes in style of components and replacement parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance. Where necessary minor mechanical modifications may be required in the replacement of components.

Parts are generally available locally for most replacements. The parts list calls out the recommended vendors where applicable.

The following parts coding are used:

CVC	Capacitor, Variable, Ceramic
CCT	Capacitor, Ceramic, Tubular
CFP	Capacitor, Fixed, Plastic
CCD	Capacitor, Ceramic, Disc
CYF	Capacitor, Mylar, Foil
CMD	Capacitor, Mica, Dipped
CMM	Capacitor, Mica, Molded
CEA	Capacitor, Electrolytic, Aluminum
CET	Capacitor, Electrolytic, Tantalum
DGP	Diode, General Purpose
DZG	Diode, Zener, General Purpose
DRP	Diode, Bridge, Power
FLT	Filter
ICP	Integrated Circuit
TRQ	Transistor
RFF	Resistor, Fixed, Film
RFC	Resistor, Fixed, Composition
RVC	Resistor, Variable, Composition
RFW	Resistor, Fixed, Wirewound
SWG	Switch
LMB	Lamp
TRX	Transformer

Resistors may generally be replaced by Corning Electronics (CGW) type N-55 and C-32. Allen Bradley composition resistors type EB are also used.

MISCELLANEOUS

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
	31400511A	ADA 30 PIN PCB INTERCONNECT	50423	
	33100000A	LNC LINE CORD SET 7FT.MLD	70903	BELDEN CORD SET BN772
	40100020A	PNT 10MM BLACK	50423	ELMA SWISS 041-202
	40100030A	KNB 10MM BLACK 1/8 SHAFT	50423	ELMA SWISS 020-222
	40100040A	CAK 10MM BLACK	50423	ELMA SWISS 040-102
	40100050A	KNB 14.5MM BLACK 3MM SHAFT	50423	ELMA SWISS 021-312 W/LINE
	40100060A	CAK 14.5MM RED	50423	ELMA SWISS 040-303
	40100070A	KNB 21MM BLK BAR 6MM SHAFT	50423	ELMA SWISS 023-442 W/LINE
	47400011A	FLM 5500A OPT FLTR NIXIE	50423	
	47400021A	FLM 5500A ANNUNCIATOR OPT	50423	
DS 1	16100050A	LMP 73/4 5V 60 MA MIN/5500A	80368	SYLVANIA 6805/36405-0 EQV
DS 2	16100050A	LMP 73/4 5V 60 MA MIN/5500A	80368	SYLVANIA 6805/36405-0 EQV
DS 3	16100050A	LMP 73/4 5V 60 MA MIN/5500A	80368	SYLVANIA 6805/36405-0 EQV
DS 4	16100050A	LMP 73/4 5V 60 MA MIN/5500A	80368	SYLVANIA 6805/36405-0 EQV
DS 5	16100050A	LMP 73/4 5V 60 MA MIN/5500A	80368	SYLVANIA 6805/36405-0 EQV
DS 6	16100050A	LMP 73/4 5V 60 MA MIN/5500A	80368	SYLVANIA 6805/36405-0 EQV

Section 7

Circuit Diagrams

This section contains component location illustrations and schematics for the 5500A. The component location illustrations identify, by reference designation, the location of all components shown on the schematics.

All the components shown on the schematics and component location illustrations are described in the parts list in Section 6. Any replacement parts required should be selected from the parts list.

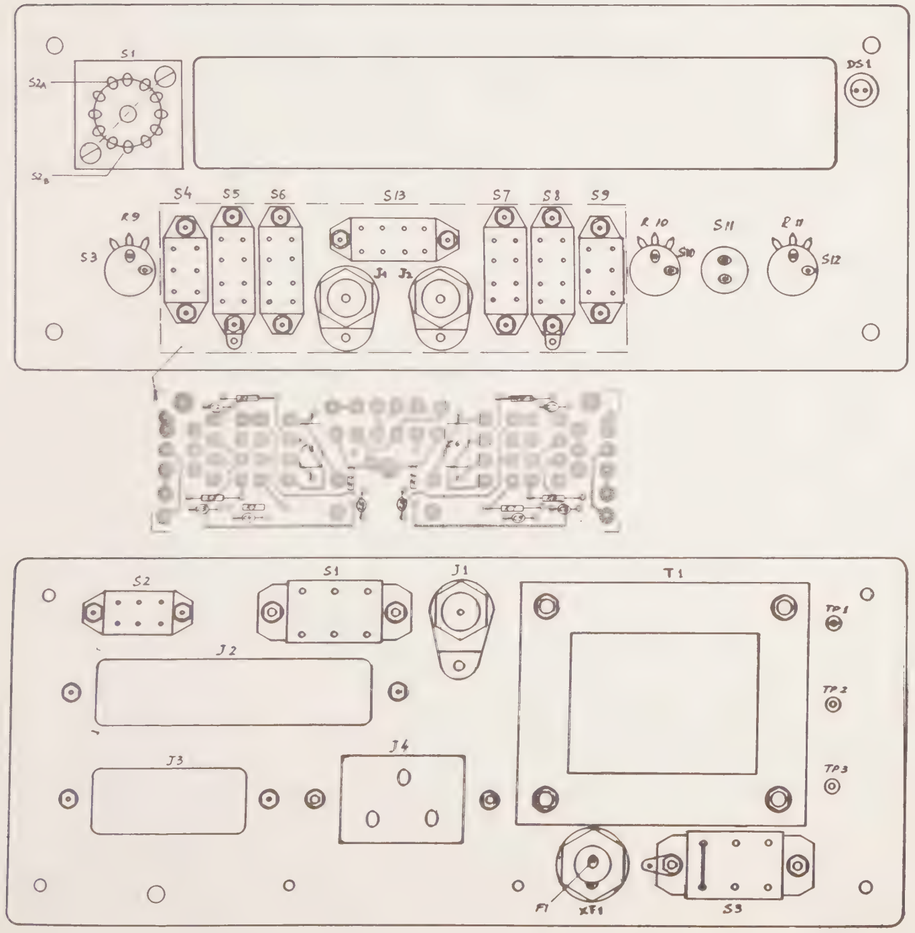


FIGURE 7-1. COMPONENT LOCATIONS, FRONT PANEL A1 & REAR PANEL A2

FRONT PANEL A1

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 1	07100050A	CYF 22.0NF 600 V		STETNER-TRU MKT1813-322/6
C 2	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 3	07100070A	CCD 47.0PF 500 V DISC	90201	RMC TYPE CG
C 4	07100080A	CCD 470.0PF 1000 V DISC	90201	RMC TYPE B
C 5	07025430A	CCD 1.5NF 3 KV M -20+80%	72982	ERIE 878 H1-K DISC Y5V
C 6	07100050A	CYF 22.0NF 600 V		STETNER-TRU MKT1813-322/6
C 7	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 8	07100070A	CCD 47.0PF 500 V DISC	90201	RMC TYPE CG
C 9	07100080A	CCD 470.0PF 1000 V DISC	90201	RMC TYPE B
C 10	07025430A	CCD 1.5NF 3 KV M -20+80%	72982	ERIE 878 H1-K DISC Y5V
DS 1	16100000A	LMP PAN GALIUM ARSENIDE	28480	(HP)-5082-4440
J 1				
J 2				
R 1	12126000A	RFF 1.00M 500 MW F+-1%	16299	CGW TYP NA 65
R 2	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW NA 60
R 3	12124000A	RFF 10.0 K 500 MW F+-1%	16299	CGW NA 60
R 4	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW NA 60
R 5	12126000A	RFF 1.00M 500 MW F+-1%	16299	CGW TYP NA 65
R 6	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW NA 60
R 7	12124000A	RFF 10.0 K 500 MW F+-1%	16299	CGW NA 60
R 8	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW NA 60
R 9	09400001A	RVC 5.0 K .25W LINEAR/SPST	50423	MALLORY
R 10	09400001A	RVC 5.0 K .25W LINEAR/SPST	50423	MALLORY
R 11	09400001A	RVC 5.0 K .25W LINEAR/SPST	50423	MALLORY
S 1	25400200C	SWC ROT DUAL CONC SP12P/SP5P	50423	
S 2	25400200C	SWC ROT DUAL CONC SP12P/SP5P	50423	
S 3	09400011A	RVC 250.0 K .25W LOG SPST	50423	MALLORY
S 4	25100220A	SWC SLIDE MIN DPDT	78488	STACKPOLE SS-91-1
S 5	25100210A	SWC SLIDE MIN DP3T	78488	STACKPOLE SS-.0
S 6	25100210A	SWC SLIDE MIN DP3T	78488	STACKPOLE SS-.0
S 7	25100210A	SWC SLIDE MIN DP3T	78488	STACKPOLE SS-.0
S 8	25100210A	SWC SLIDE MIN DP3T	78488	STACKPOLE SS-.0
S 9	25100220A	SWC SLIDE MIN DPDT	78488	STACKPOLE SS-91-1
S 10	09400001A	RVC 5.0 K .25W LINEAR/SPST	50423	MALLORY
S 11	25100020A	SWC MOM PB SPST NO	81073	GRAYHILL 30-1(0130-15)
S 12	09400011A	RVC 250.0 K .25W LOG SPST	50423	MALLORY
S 13	25100210A	SWC SLIDE MIN DP3T	78488	STACKPOLE SS-.0

REAR PANEL A2

SCHEM REF	BALLANTINE PART NO	D E S C R I P T I O N	MFR CODE	MFR PART NUMBER
F 1	19034110A	FUS .5AMP SLOBLOW TYPE 3AG	75915	LITTELFUSE 313.500
FL 1	14100000A	REG LINE SURGE SUPPRESSOR	24446	GE VP 150A10
J 1				
J 2	31095130A	CON BLUE RIBBON,PANEL MTG.	29587	50 PIN, AMPHENOL 57-40500
J 3	31095110A	REC	29587	AMPHENOLL#57-40240
J 4	31100000A	REC AC POWER	82389	SWITCHCRAFT
J 3-1				
J 3-2				
S 1	25077860A	SWC LINE VOLTAGE-SLIDE	82389	SWITCHCRAFT #46256LP
S 2	25100220A	SWC SLIDE MIN DPDT	78488	STACKPOLE SS-91-1
S 3	25077860A	SWC LINE VOLTAGE-SLIDE	82389	SWITCHCRAFT #46256LP
T 1	20400050A	TRX PWR XFORM FOR 5500A	50423	
TP 1				
TP 2				
TP 3				

DISPLAY ASSEMBLY A4

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 1	07100080A	CCD 470.0PF 1000 V DISC	90201	RMC TYPE B
C 2	07023550A	CCD 22 NP 200 V K 10%	92741	GOODALL TYPE 621M
C 3	07100530A	CET 10.0UF 35.0V M	56289	SPRAGUE 1960106X0035A3
C 4	07023550A	CCD 22 NP 200 V K 10%	92741	GOODALL TYPE 621M
C 5	07023550A	CCD 22 NP 200 V K 10%	92741	GOODALL TYPE 621M
C 6	07023550A	CCD 22 NP 200 V K 10%	92741	GOODALL TYPE 621M
C 7	07023550A	CCD 22 NP 200 V K 10%	92741	GOODALL TYPE 621M
CR 1	05100250A	DSP 1N281 GERMANIUM	15238	ITT
CR 2	05100250A	DSP 1N281 GERMANIUM	15238	ITT
CR 3	05100250A	DSP 1N281 GERMANIUM	15238	ITT
CR 4	05100250A	DSP 1N281 GERMANIUM	15238	ITT
CR 5	05094810A	DSP IN4005	04713	MOTOROLA
CR 6	05094810A	DSP IN4005	04713	MOTOROLA
CR 7	05094810A	DSP IN4005	04713	MOTOROLA
CR 8	05100250A	DSP 1N281 GERMANIUM	15238	ITT
CR 9	05100250A	DSP 1N281 GERMANIUM	15238	ITT
CR 10	05100250A	DSP 1N281 GERMANIUM	15238	ITT
DS 1	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
DS 2	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
DS 3	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
DS 4	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
DS 5	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
DS 6	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
DS 7	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
DS 8	21100000A	TBE NIXIE NUMERIC	83594	BURROUGHS
J 1				
Q 1	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 2	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 3	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 4	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 5	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 6	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 7	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 8	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 9	10100340A	TRO 2N4124 NPN	04713	MOTOROLA
Q 10	10079490A	TRO 2N4410	04713	MOTOROLA
Q 11	10079490A	TRO 2N4410	04713	MOTOROLA
Q 12	10079490A	TRO 2N4410	04713	MOTOROLA
R 1	12124240A	RFF 17.8 K 500 MW F+-1%	16299	CGW NA 60
R 2	12124240A	RFF 17.8 K 500 MW F+-1%	16299	CGW NA 60
R 4	12124240A	RFF 17.8 K 500 MW F+-1%	16299	CGW NA 60
R 5	12124240A	RFF 17.8 K 500 MW F+-1%	16299	CGW NA 60

DISPLAY ASSEMBLY A4 (Continued)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 6	12124240A	RFF 17.8 K 500 MW F+-1%	16299	CGW NA 60
R 7	12124240A	RFF 17.8 K 500 MW F+-1%	16299	CGW NA 60
R 8	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 9	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 10	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 11	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 12	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 13	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 14	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 15	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 16	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 17	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 18	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 19	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 20	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 21	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 22	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 23	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 24	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 25	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 26	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 27	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 28	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 29	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 30	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 31	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 32	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 33	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 34	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 35	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 36	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 37	12122560A	RFF 383.0 500 MW F+-1%	16299	CGW NA 60
R 38	12122560A	RFF 383.0 500 MW F+-1%	16299	CGW NA 60
R 39	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 40	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 41	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 42	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 43	12123000A	RFF 1.0 K 500 MW F+-1%	16299	CGW NA 60
R 46	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 47	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 48	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 49	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 50	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 51	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60

DISPLAY ASSEMBLY A4 (Continued)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 52	12122520A	RFF 348.0 500 MW F+-1%	16299	CGW NA 60
R 53	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 54	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 55	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 56	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 57	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 58	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 59	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 60	12123520A	RFF 3.48K 500 MW F+-1%	16299	CGW NA 60
R 61	12123520A	RFF 3.48K 500 MW F+-1%	16299	CGW NA 60
R 62	12123520A	RFF 3.48K 500 MW F+-1%	16299	CGW NA 60
R 63	12124240A	RFF 17.8 K 500 MW F+-1%	16299	CGW NA 60
R 64	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 65	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 66	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 67	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW NA 60
R 68	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 69	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 70	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
U 1	24094100A	ICP MOTOROLA MC846P OR	04713	RCA CD 2302E/846
U 2	24094140A	ICP T.I.SN7430N OR	01295	SPRAGUE USN7430A
U 3	24094070A	ICP T.I.SN7400N OR	56289	SPRAGUE USN7400A
U 4	24100160A	ICP 7404 TTL HEX INVERTER	01295	TEXAS INSTRUMENT
U 5	24094100A	ICP MOTOROLA MC846P OR	04713	RCA CD 2302E/846
U 6	24100200A	ICP 7453 TTL 4-INP AND/OR	04713	MOTOROLA
U 7	24094100A	ICP MOTOROLA MC846P OR	04713	RCA CD 2302E/846
U 8	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 9	24094100A	ICP MOTOROLA MC846P OR	04713	RCA CD 2302E/846
U 10	24100240A	ICP 9312 8-INP MULTIPX	04713	MOTOROLA/8230 SIGNETICS
U 11	24100260A	ICP 8290 TTL DEC-COUNTER	18324	SIGNETICS
U 12	24100140A	ICP 8280 TTL DEC.CTR	18324	SIGNETICS
U 13	24100140A	ICP 8280 TTL DEC.CTR	18324	SIGNETICS
U 14	24100140A	ICP 8280 TTL DEC.CTR	18324	SIGNETICS
U 15	24100140A	ICP 8280 TTL DEC.CTR	18324	SIGNETICS
U 16	24100140A	ICP 8280 TTL DEC.CTR	18324	SIGNETICS
U 17	24100140A	ICP 8280 TTL DEC.CTR	18324	SIGNETICS
U 18	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 19	24100220A	ICP 74145 TTL LATCH DECOR	01295	TEXAS INSTRUMENT
U 20	24094100A	ICP MOTOROLA MC846P OR	04713	RCA CD 2302E/846
U 21	24100340A	ICP 936 DTL HEX INVERTER	04713	MOTOROLA
U 22	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 23	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 24	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 25	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 26	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 27	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 28	24100150A	ICP 7475 TTL	18324	SIGNETICS
U 29	24100130A	ICP 7441	18324	SIGNETICS
U 30	24100130A	ICP 7441	18324	SIGNETICS
U 31	24100130A	ICP 7441	18324	SIGNETICS
U 32	24100130A	ICP 7441	18324	SIGNETICS
U 33	24100130A	ICP 7441	18324	SIGNETICS
U 34	24100130A	ICP 7441	18324	SIGNETICS
U 35	24100130A	ICP 7441	18324	SIGNETICS
U 36	24100130A	ICP 7441	18324	SIGNETICS

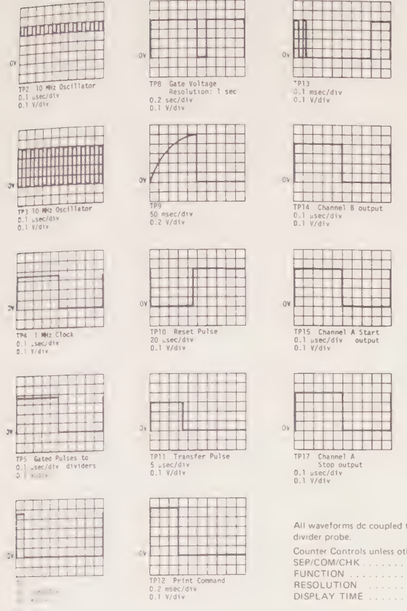


FIGURE 7-3. TEST POINT WAVEFORMS, MOTHERBOARD A3

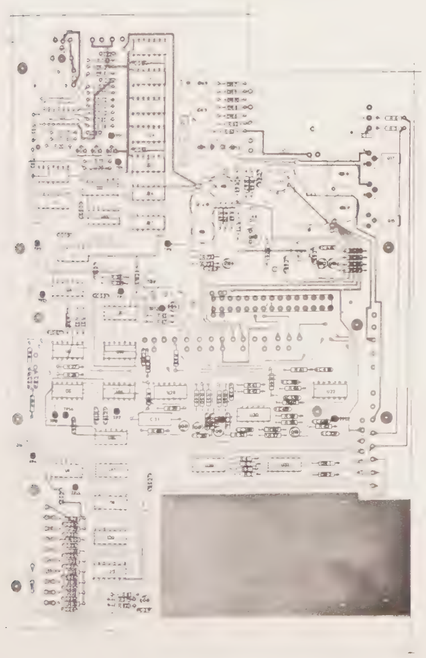


FIGURE 7-2. COMPONENT LOCATIONS, MOTHERBOARD A3

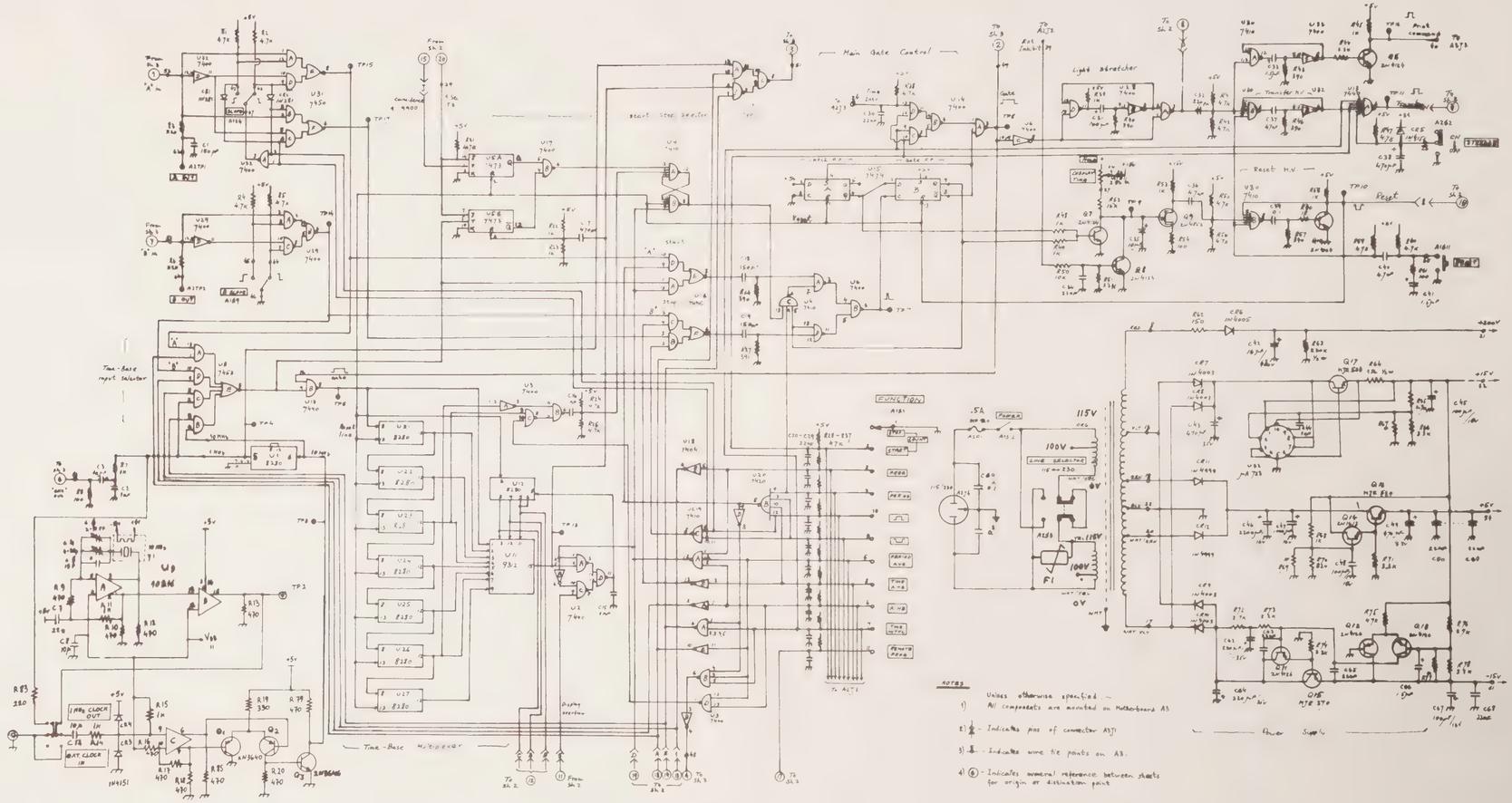

Main Gate Control
Start Stop Selector
Light Stretcher
Reset H.V.
Time-Base Multiplexer
Power Supply
Time-base input selector
Display Interface
NOTES
1) Unless otherwise specified — All components are mounted on Motherboard A3
2) Indicates pins of connector A3J1
3) Indicates wire tie points on A3.
4) Indicates numerical reference between sheets for origin or destination point

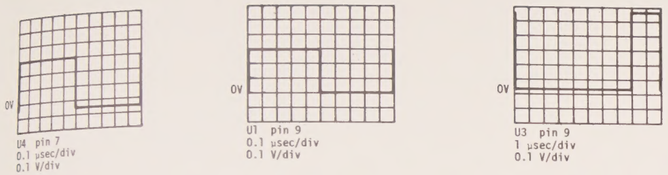
FIGURE 7-4. SCHEMATIC, MOTHERBOARD A3

INPUT ASSEMBLY A5

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 1	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 2	07100860A	CCD 68.0PF 500 V	90201	RMC TYPE CG
C 4	07100820A	CCD 0.1UF 50. V	84171	ARCO TYPE CY30-C-1042
C 5	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 6	07100820A	CCD 0.1UF 50. V	84171	ARCO TYPE CY30-C-1042
C 7	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 8	07100820A	CCD 0.1UF 50. V	84171	ARCO TYPE CY30-C-1042
C 9	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 10	07100820A	CCD 0.1UF 50. V	84171	ARCO TYPE CY30-C-1042
C 11	07095610A	CCD 1 NF 1 KV K 10%	84171	ARC TYP CCS-102
C 12	07100820A	CCD 0.1UF 50. V	84171	ARCO TYPE CY30-C-1042
C 13	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 14	07100820A	CCD 0.1UF 50. V	84171	ARCO TYPE CY30-C-1042
C 15	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 16	07100810A	CCD 3.3PF 500. V	90201	RMC TYPE GG
C 17	07100860A	CCD 68.0PF 500 V	90201	RMC TYPE CG
C 18	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 19	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 20	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 21	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 22	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 23	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 24	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 25	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 26	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 27	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 28	07100810A	CCD 3.3PF 500. V	90201	RMC TYPE GG
C 29	07095610A	CCD 1 NF 1 KV K 10%	84171	ARC TYP CCS-102
C 30	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 31	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 32	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 33	07100830A	CET 1.5UF 35 V DISC	56289	SPRAGUE 1960155X0035A3
C 36	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
C 37	07100280A	CCD1000. PF 1 KV DC	84171	ELMENCO TYPE CCD 102
CR 1	05100260A	DGP 1N4151 SILICON	24446	GE
CR 2	05100260A	DGP 1N4151 SILICON	24446	GE
CR 3	05100350A	DZG 10.0V 200.0MW IN758A	04713	MOTOROLA
CR 4	05100260A	DGP 1N4151 SILICON	24446	GE
CR 5	05100250A	DGP 1N281 GERMANIUM	15238	ITT
CR 6	05094620A	DGP HPA 2800	28480	HEWLETT-PACKARD
CR 7	05100260A	DGP 1N4151 SILICON	24446	GE
CR 8	05100260A	DGP 1N4151 SILICON	24446	GE
CR 9	05100170A	DGP 1N746A	12954	DICKSON ELECTRONICS
CR 10	05100000A	DZG 6.2V +-5% 400MW IN753A	12954	DICKSON ELECTRONICS
L 1	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 2	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 3	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 4	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 5	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 6	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 7	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 8	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 9	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 10	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 11	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 12	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 13	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 14	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
L 15	46100000A	FRB FERRITE BEAD	78488	STACKPOLE 57-0180-7D MAT
Q 1	10100630A	TRQ 2N3955	07263	FAIRCHILD 2N3955
Q 2	10100370A	TRQ 2N5179 NPN 2N5179	04713	MOTOROLA
Q 3	10100370A	TRQ 2N5179 NPN 2N5179	04713	MOTOROLA
Q 4	10100330A	TRQ 2N3646 NPN	04713	MOTOROLA
Q 5	10100330A	TRQ 2N3646 NPN	04713	MOTOROLA
Q 6	10079340A	TRQ 2N3640	07263	FAIRCHILD
Q 7	10079340A	TRQ 2N3640	07263	FAIRCHILD
Q 8	10100330A	TRQ 2N3646 NPN	04713	MOTOROLA
Q 9	10100630A	TRQ 2N3955	07263	FAIRCHILD 2N3955
Q 10	10100350A	TRQ 2N4126 PNP	04713	MOTOROLA

INPUT ASSEMBLY A5 (Continued)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
Q 11	10100350A	TRQ 2N4126 PNP	04713	MOTOROLA
R 1	12121720A	RFF 56.2 500 MW F+-1%	16299	CGW NA 60
R 2	12124000A	RFF 10.0 K 500 MW F+-1%	16299	CGW NA 60
R 3	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA60
R 4	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 5	09101090A	RVC 20.0 500.0MV	32997	BOURNS 3329H SERIES
R 6	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 7	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 8	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 9	12124000A	RFF 10.0 K 500 MW F+-1%	16299	CGW NA 60
R 10	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 11	12126000A	RFF 1.00M 500 MW F+-1%	16299	CGW TYP NA 65
R 12	12123170A	RFF 1.50K 500 MW F+-1%	16299	CGW NA 60
R 13	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW NA 60
R 14	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW NA 60
R 15	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 16	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 17	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW NA 60
R 18	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW NA 60
R 19	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 20	12122640A	RFF 464.0 500 MW F+-1%	16299	CGW NA 60
R 21	12122640A	RFF 464.0 500 MW F+-1%	16299	CGW NA 60
R 22	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 23	12127050A	RFC 47.0 125 MW J	01121	A-B 1/8 W OR EQUIV.
R 24	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW NA 60
R 25	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW NA 60
R 26	12122640A	RFF 464.0 500 MW F+-1%	16299	CGW NA 60
R 27	12122640A	RFF 464.0 500 MW F+-1%	16299	CGW NA 60
R 28	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW NA 60
R 29	12121520A	RFF 34.8 500 MW F+-1%	16299	CGW NA 60
R 30	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 31	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 32	12123000A	RFF 1.0 K 500 MW F+-1%	16299	CGW NA 60
R 33	12123400A	RFF 2.61K 500 MW F+-1%	16299	CGW NA 60
R 34	12122640A	RFF 464.0 500 MW F+-1%	16299	CGW NA 60
R 35	12121640A	RFF 46.4 500 MW F+-1%	16299	CGW NA 60
R 36	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 37	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 38	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 39	12121720A	RFF 56.2 500 MW F+-1%	16299	CGW NA 60
R 40	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 41	09100450A	RVF 1.0K PC TRIMPOT 5500A	32997	BOURNS 3329H SERIES
R 42	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 43	12121800A	RFF 68.1 500 MW F+-1%	16299	CGW NA 60
R 44	12123170A	RFF 1.50K 500 MW F+-1%	16299	CGW NA 60
R 45	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 46	12121800A	RFF 68.1 500 MW F+-1%	16299	CGW NA 60
R 47	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 48	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW NA 60
R 49	12126000A	RFF 1.00M 500 MW F+-1%	16299	CGW TYP NA 65
R 50	12123170A	RFF 1.50K 500 MW F+-1%	16299	CGW NA 60
R 51	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW NA 60
R 52	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 53	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW NA 60
R 54	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW NA 60
R 55	12123640A	RFF 4.64K 500 MW F+-1%	16299	CGW NA 60
R 56	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 57	12122320A	RFF 215.0 500 MW F+-1%	16299	CGW NA 60
R 58	12124160A	RFF 14.7 K 500 MW F+-1%	16299	CGW NA 60
R 59	12123560A	RFF 3.83K 500 MW F+-1%	16299	CGW NA 60
R 60	12122640A	RFF 464.0 500 MW F+-1%	16299	CGW NA 60
U 1	24100300A	ICP 7400 TTL SCHOTTKY	01295	TEXAS INSTRUMENT
U 2	24100320A	ICP 745112 DUAL JK SCHOTTKY	01245	TEXAS INSTRUMENT
U 3	24100320A	ICP 745112 DUAL JK SCHOTTKY	01245	TEXAS INSTRUMENT
U 4	24100400A	ICP LIN COMPARATOR 710	07263	FAIRCHILD 8 PIN CAN
U 5	24100410A	ICP LIN DUAL OD AMP 10116	04713	MOTOROLA



All waveforms dc coupled through 10:1 divider probe.

Counter Controls unless otherwise specified:

SEP/COM/CHK	CHK
FUNCTION	FREQ
RESOLUTION	4
TRIG LEVEL	PSET
DISPLAY TIME	min

FIGURE 7-9. TEST POINT WAVEFORMS, INPUT CIRCUIT A5

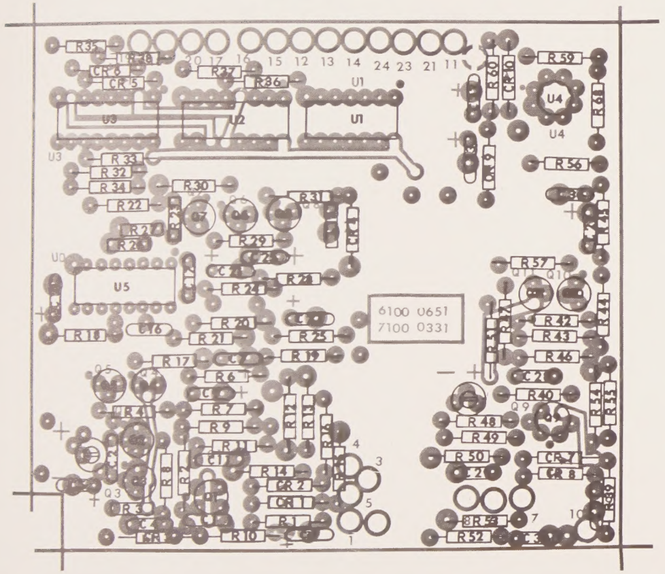


FIGURE 7-8. COMPONENT LOCATIONS, INPUT CIRCUIT A5

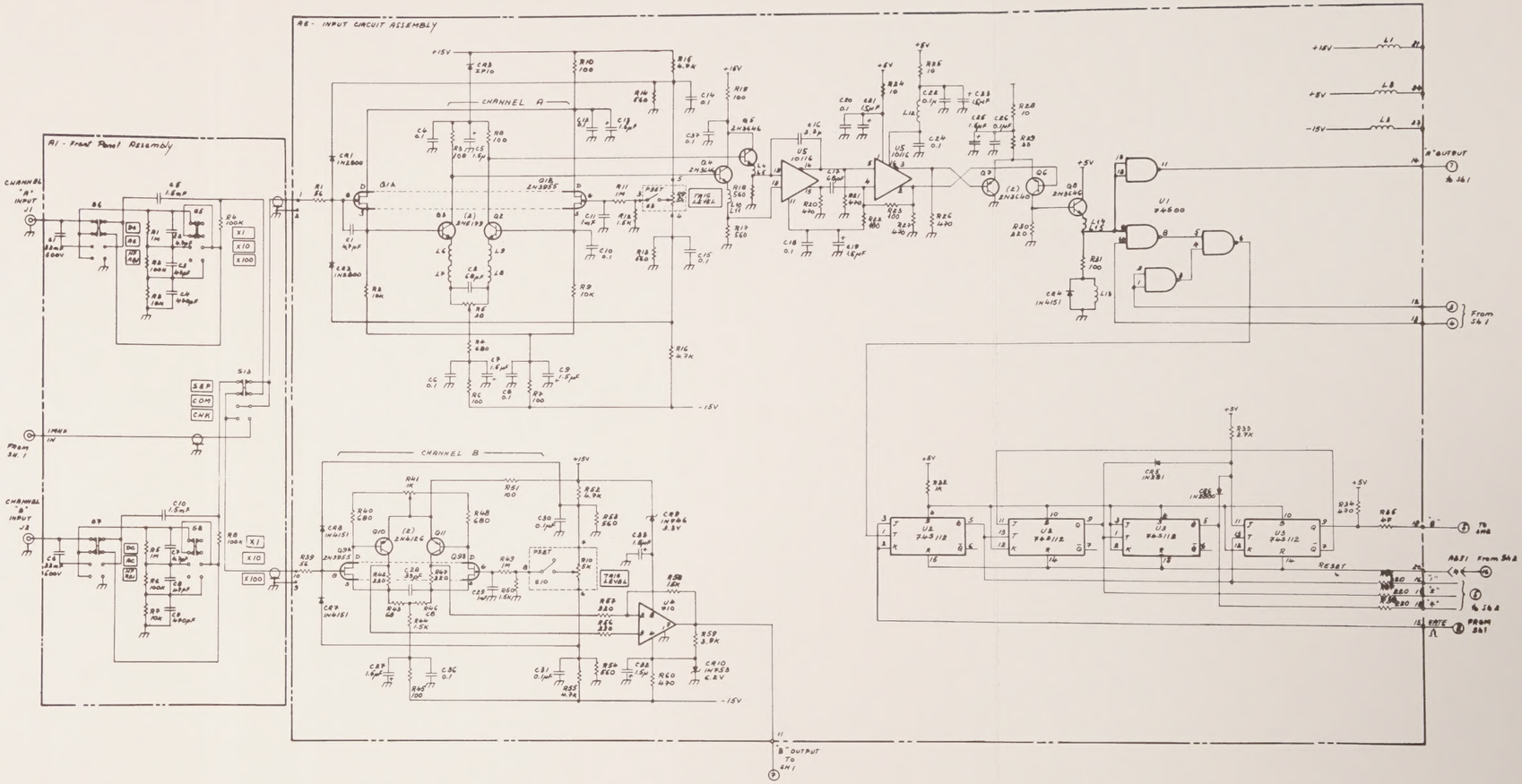
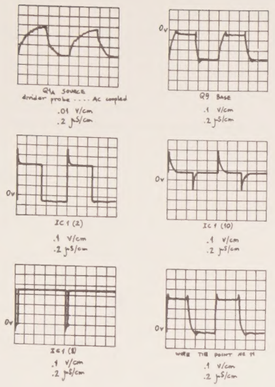


FIGURE 7-10. SCHEMATIC, FRONT PANEL A1 & INPUT CIRCUIT A5

SYMBOL	DESCRIPTION	MFR	BLI P/N
	INPUT ASSEMBLY A5		
C1	CCD 0.1 uF 50 V	RMC	071-0082-0A
C2	CCT 10 uF 35 V	Sprague	071-0053-0A
C3	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C4	CCT 10 uF 35 V	Sprague	071-0053-0A
C5	CCD 0.1 uF 50 V	RMC	071-0082-0A
C6	CCD 0.01 uF 160 V	RMC	070-9009-0A
C7	CCD 22 nF 160 V	RMC	070-2355-0A
C8	CCD 22 nF 160 V	RMC	070-2355-0A
C9	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C10	CCD 3.3 pF 500 V	RMC	071-0081-0A
C11	CCD 0.1 nF 50 V	RMC	071-0082-0A
C12	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C13	CCD 22 nF 160 V	RMC	070-2355-0A
C14	CCD 22 nF 160 V	RMC	070-2355-0A
C15	CCD 22 pF 500 V	RMC	071-0085-0A
C16	CCT 10 uF 35 V	Sprague	071-0053-0A
C17	CCD 0.1 uF 50 V	RMC	071-0082-0A
C18	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C19	CCD 68 pF 500 V	RMC	071-0086-0A
C20	CCD 220 pF 600 V	RMC	070-9575-0A
C21	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C22	CCD 33 pF 500 V	RMC	070-9560-0A
C23	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C24	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C25	CCD 0.01 uF 160 V	RMC	070-9009-0A
C26	CCD 22 nF 160 V	RMC	070-2355-0A
C27	CCD 22 nF 160 V	RMC	070-2355-0A
C28	CCT 1.5 uF 35 V	Sprague	071-0083-0A
C29	CCT 1.5 uF 35 V	Sprague	071-0083-0A
CR1	Diode, Hot Carrier HP-2800	H.P.	050-9462-0A
CR2	Diode, Hot Carrier HP-2800	H.P.	050-9462-0A
CR3	Diode, Zener 1N756 (8.2 V)	MOT	050-0494-0A
CR4	Diode, Zener 1N750 (4.7 V)	MOT	051-1001-0A
CR5	Diode, Zener 1N753 (6.2 V)	MOT	051-1000-0A
CR6	Diode, Germanium 1N281	ITT	051-0025-0A
CR7	Diode, Germanium 1N281	ITT	051-0025-0A
CR8	Diode, Silicon 1N4151	MOT	051-0026-0A
CR9	Diode, Silicon 1N4151	MOT	051-0026-0A
CR10	Diode, Zener 1N746 (3.3 V)	MOT	051-0017-0A
CR11	Diode, Zener 1N753 (6.2 V)	MOT	051-0000-0A
CR12	Diode, Hot Carrier HP-2800	H.P.	050-9462-0A
L1	Ferrite Bead Ceramag 24	Stackpole	461-0003-0A
L2	Ferrite Bead Ceramag 7D	Stackpole	461-0004-0A
Q1	FET (Dual) UC-2149	U.C.	101-0039-0A
Q2	Transistor NPN 2N5179	MOT	101-0037-0A
Q3	Transistor NPN 2N5179	MOT	101-0037-0A
Q4	Transistor NPN 2N4124	MOT	101-0034-0A
Q5	Transistor NPN 2N4124	MOT	101-0034-0A
Q6	Transistor PNP 2N4126	MOT	101-0035-0A
Q7	Transistor NPN 2N3646	MOT	101-0033-0A
Q8	Transistor NPN 2N3646	MOT	101-0033-0A
Q9	Transistor NPN 2N5179	MOT	101-0037-0A
Q10	Transistor NPN 2N5179	MOT	101-0037-0A
Q11	Transistor NPN 2N5179	MOT	101-0037-0A
Q12	FET (Dual) UC-2149	U.C.	101-0039-0A
Q13	Transistor PNP 2N4126	MOT	101-0035-0A
Q14	Transistor PNP 2N4126	MOT	101-0035-0A
Q15	Transistor NPN 2N3646	MOT	101-0033-0A
R1	RFF 1% 1/4W 46.4	CGW	121-2164-0A
R2	RFF 1% 1/4W 10k	CGW	121-2400-0A
R3	RFC 5% 1/8W 33	AB	121-2703-0A
R4	RFF 1% 1/4W 2150	CGW	121-2332-0A
R5	RFF 1% 1/4W 2150	CGW	121-2332-0A
R6	RVC 1k	Bourns	091-0045-0A
R7	RFC 1% 1/4W 46.4	CGW	121-2164-0A
R8	RFF 1% 1/4W 38.3	CGW	121-2156-0A
R9	RFC 5% 1/8W 33	AB	121-2703-0A

SYMBOL	DESCRIPTION	MFR	BLI P/N
	INPUT ASSEMBLY A5		
R10	RFF 1% 1/4W 10k	CGW	121-2400-0A
R11	RFF 1% 1/4W 1470	CGW	121-2316-0A
R12	RFC 5% 1/4W 1M	AB	121-2600-0A
R13	RFC 1% 1/4W 4640	CGW	121-2364-0A
R14	RFC 1% 1/4W 562	CGW	121-2272-0A
R15	RFC 1% 1/4W 4640	CGW	121-2364-0A
R16	RFC 1% 1/4W 567	CGW	121-2272-0A
R17	RVC 1% 1/4W 500	Bourns	091-0044-0A
R18	RFF 1/ 1/4W 681	CGW	121-2280-0A
R19	RFF 1% 1/4W 562	CGW	121-2272-0A
R20	RFF 1% 1/4W 681	CGW	121-2280-0A
R21	RFC 5% 1/8W 220	AB	121-2710-0A
R22	RFF 1% 1/4W 1210	CGW	121-2308-0A
R23	RFC 5% 1/8W 27	AB	121-2702-0A
R24	RFF 1% 1/4W 100	CGW	121-2200-0A
R25	RFF 1% 1/4W 3480	CGW	121-2352-0A
R26	RFF 1% 1/4W 348	CGW	121-2252-0A
R27	RFC 5% 1/8W 27	AB	121-2702-0A
R28	RFC 1% 1/4W 1780	CGW	121-2224-0A
R29	RFC 5% 1/8W 10	AB	121-2700-0A
R30	RFF 1% 1/4W 26.1	CGW	121-2140-0A
R31	RFF 1% 1/4W 261	CGW	121-2240-0A
R32	RFF 1% 1/4W 1k	CGW	121-2300-0A
R33	RFF 1% 1/4W 562	CGW	121-2272-0A
R34	RFF 1% 1/4W 2610	CGW	121-2340-0A
R35	RFF 1% 1/4W 1210	CGW	121-2308-0A
R36	RFF 1% 1/4W 1k	CGW	121-2300-0A
R37	RFF 1% 1/4W 348	CGW	121-2252-0A
R38	RFF 1% 1/4W 215	CGW	121-2232-0A
R39	RFF 1% 1/4W 1470	CGW	121-2316-0A
R40	RFF 1% 1/4W 1k	CGW	121-2300-0A
R41	RFF 1% 1/4W 464	CGW	121-2264-0A
R42	RFF 1% 1/4W 464	CGW	121-2264-0A
R43	RFF 1% 1/4W 46.4	CGW	121-2164-0A
R44	RFF 1% 1/4W 215	CGW	121-2232-0A
R45	RFF 1% 1/4W 215	CGW	121-2232-0A
R46	RFF 1% 1/4W 215	CGW	121-2332-0A
R47	RFF 1% 1/4W 46.4	CGW	121-2164-0A
R48	RFF 1% 1/4W 681	CGW	121-2280-0A
R49	RVC 1% 1/4W 1k	Bourns	091-0045-0A
R50	RFC 5% 1/8W 220	AB	121-2710-0A
R51	RFC 5% 1/8W 220	AB	121-2710-0A
R52	RFC 5% 1/8W 68	AB	121-2707-0A
R53	RFC 5% 1/8W 68	AB	121-2707-0A
R54	RFF 1% 1/4W 1470	CGW	121-2316-0A
R55	RFF 1% 1/4W 100	CGW	121-2200-0A
R56	RFF 1% 1/4W 687	CGW	121-2280-0A
R57	RFF 1% 1/4W 100	CGW	121-2200-0A
R58	RFC 5% 1/4W 1M	AB	121-2600-0A
R59	RFF 1% 1/4W 4640	CGW	121-2364-0A
R60	RFF 1% 1/4W 562	CGW	121-2272-0A
R61	RFF 1% 1/4W 562	CGW	121-2272-0A
R62	RFF 1% 1/4W 4640	CGW	121-2364-0A
R63	RFF 1% 1/4W 215	CGW	121-2232-0A
R64	RFF 1% 1/4W 215	CGW	121-2232-0A
R65	RFF 1% 1/4W 14.7k	CGW	121-2416-0A
R66	RFF 1% 1/4W 3830	CGW	121-2356-0A
R67	RFF 1% 1/4W 464	CGW	121-2264-0A
U1	IC, TTL (Schottky) 74S00	TI	241-0030-0A
U2	IC, TTL (Schottky) 74S112	TI	241-0032-0A
U3	IC, TTL (Schottky) 74S112	TI	241-0032-0A
U4	IC, Comparator 710	Fairch	241-0040-0A



All waveforms dc coupled through 10:1 divider probe.

Counter Controls unless otherwise specified:
SEP/COM/CHK . . . . . CHK
FUNCTION . . . . . FREQ
RESOLUTION 4
TRIG LEVEL . . . . . PSET
DISPLAY TIME . . . . . min

FIGURE 7-11-B TEST POINT WAVEFORMS, INPUT CIRCUIT A5

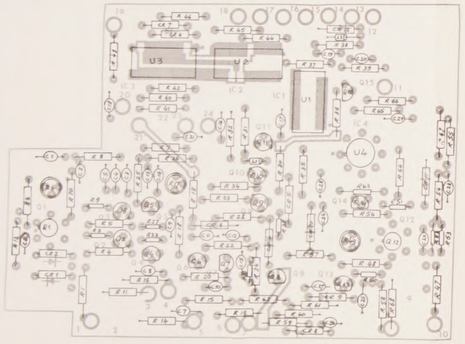


FIGURE 7-11-A COMPONENT LOCATIONS, INPUT CIRCUIT A5

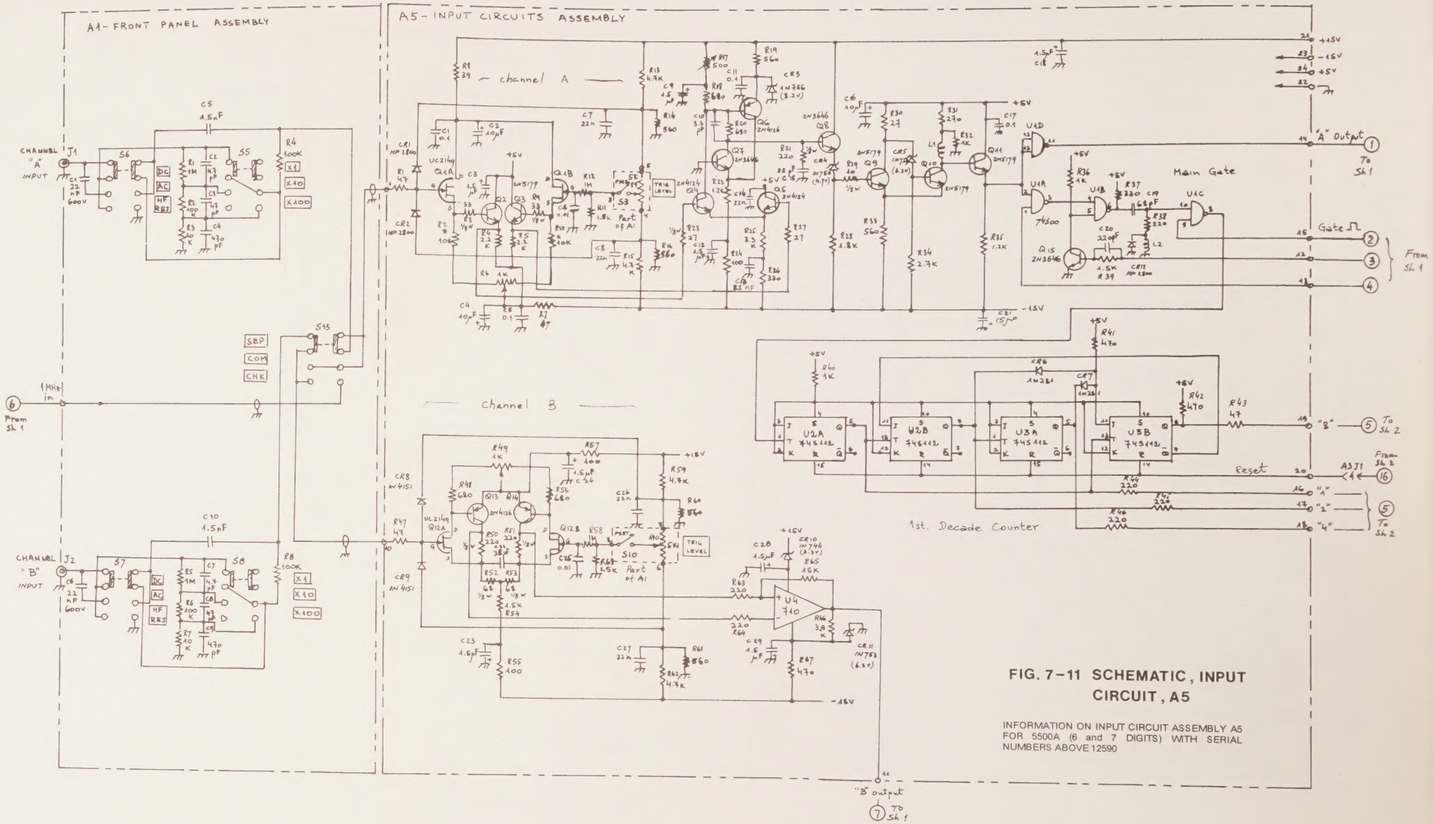


FIG. 7-11 SCHEMATIC, INPUT CIRCUIT, A5

INFORMATION ON INPUT CIRCUIT ASSEMBLY A5 FOR 5500A (6 and 7 DIGITS) WITH SERIAL NUMBERS ABOVE 12590

MP MASTER
MA31978